# Cruise Report of the Japanese Whale Research Program Under a Special Permit for North Pacific Minke Whales in 1995 with the result of a preliminary analysis of data collected

Yoshihiro Fujise [1], Toshihide Iwasaki [2], Ryoko Zenitani [1], Jun Araki [3], Koji Matsuoka [1], Tsutomu Tamura [4], Sayaka Aono [5], Takashi Yoshida [1], Hiroo Hidaka [1], Tosimitsu Nibe [6], and Daisuke Tohyama [7]

[1] *The Institute of Cetacean Research, 4-18, Toyomi-cho, Chuo-ku, Tokyo 104, Japan.*
[2] *National Research Institute of Far Seas Fisheries, 5-7-1, Orido, Shimizu, Shizuoka 424, Japan.*
[3] *Meguro Parasitological Museum, 4-1-1, Shimomeguro, Meguro-ku, Tokyo 153, Japan.*
[4] *Faculty of Fisheries, Hokkaido University, 3-1-1, Minato-cho, Hakodate, Hokkaido 041, Japan.*
[5] *Faculty of Agriculture, Ehime University, Tarumi 3-5-7, Matsuyama, Ehime 790, Japan.*
[6] *Tokyo University of Fisheries, Kouman, Minato-ku, Tokyo 125, Japan.*
[7] *Nippon Kyoudou Senpaku Co. Ltd., Higashi-nihonbashi, Chuo-ku, Tokyo 103, Japan.*

## ABSTRACT

The 1995 Japanese Whale Research Program Under Special Permit in the Northwestern Part of the North Pacific (JARPN) was conducted in a part of sub-area 9 established by the IWC/SC as a feasibility study using three sighting/sampling vessels and one research base. A total of 11,843.9 n.miles were searched, resulting in sighting of 144 schools/151 animals (primary sighting: 90 schools/91 animals, secondary sighting: 54 schools/60 animals) of minke whales. Also sighted during the research periods were blue whales (12 schools/24 animals), fin whales (18 schools/24 animals), sei whales (18 schools/25 animals), humpback whales (23 schools/40 animals), sperm whales (283 schools/319 animals) and right whales (2 schools/2 animals). Sampling activities were conducted on 131 schools/138 animals minke whales, resulting in the catch of 100 minke whales (91 male animals, 9 female animals). The collected samples were predominantly large males, and seven out of nine females samples had fetus. From the body length of the fetus, it was found that the conception period of those pregnant animals coincided roughly with that of the Okhotsk Sea-West Pacific stock ('O'stock). Furthermore, these minke whales widely consumed zooplankton and pelagic fish species. The most frequent species found in stomach of minke whale was the Pacific saury (*Cololabis saira*). Furthermore, the parasite *Anisakis simplex* was detected from the stomach and *Bolbosome* sp. from intestine of all the whales sampled.

## INTRODUCTION

The Japanese Whale Research Program Under the Special Permit in the Northwestern Part of the North Pacific (JARPN) was designed by the Government of Japan with the aim to elucidate

the stock structure of minke whales distributed in the area surrounding Japan, in preparation for the future implementation of the Revised Management Procedure (RMP) developed by the International Whaling Commission/Scientific Committee (IWC/SC). A research plan was submitted to the IWC/SC in 1994 (The Government of Japan, 1994). In 1994, the first year of the program, a feasibility study was conducted from 6 July to 7 September in a part of sub-area 9 (north of 35°N, 157-170°E) established by the IWC, but, due to adverse weather conditions, no adequate research activities were conducted, with the result of sampling of only 21 whales (Fujise *et al.*, 1995). Samples and data collected in this research were analyzed extensively by experts after the cruise. The results suggested that minke whales distributed in sub-area 9 have a similar breeding cycle with those in the Pacific coast of Japan. No substantial difference in genetics (isozyme and mtDNA), morphology, and accumulations of heavy metals and organochlorines between sub-area 9 and Pacific coast of Japan, were detected (Goto and Pastene, 1995; Fujise and Kato, 1995; Fujise, 1995; Fujise *et al.*, 1995; Kuramochi *et al.*, 1995). However, because of small sample size for sub-area 9, no decisive conclusion was reached. For this reason, the Government of Japan decided to continue the feasibility study in the same area and submitted to the IWC/SC a research plan in 1995 (The Government of Japan, 1995).

This report outlines the 2nd cruise of JARPN in sub-area 9 conducted from 13 June to 22 August in 1995 and presents some results of preliminary analysis.

## RESEARCH METHODS

### 1. Research area

Research area was a part of sub-area 9 established by the IWC: north of 40°N, 157-170°E (excluding the exclusive 200 n.miles zones of the United States and Russia) (Fig. 1). In the first period the entire research area was surveyed, and in the second and third periods, the survey conducted in the western and eastern parts of the research area, respectively.

### 2. Research vessels

*Nisshin Maru* (7,440GT) was used as a research base, which commanded the research and engaged in biological examination of collected samples and of by-products. Furthermore, it engaged oceanographic observation using XBT and collection of information on sea and weather conditions. Sighting surveys and sampling of minke whales were conducted by three sighting/sampling vessels: *Kyo Maru No.1* (*K01*: 812.08GT), *Toshi Maru No. 25* (*T25*: 739.92GT) and *Toshi Maru No. 18* (*T18*: 758.33GT). One of three vessels was added newly in this cruise. The sighting/sampling vessels also conducted various experiments and observations, such as photographing of natural marks, biopsy sampling, observation of behavior patterns of large whales, angle and distance experiment.

### 3. Cruise trackline

The research was carried out in three periods, with different methods of establishing research courses used for each period. In the first period (13-30 June, 1995), the trackline was established, as in 1994, through the billiard method by means of fixed angle of reflection using the line transect method. In the second and third periods (1 July-6 August and 7-22 August, 1995, respectively), sub-areas were established in parts of the research area, in which zigzag research course was established on an arbitrary basis, taking into consideration the sighting of minke whales and sea weather condition observations in the first period. Furthermore, during

the survey in the second and third periods; separate courses attaching emphasis on the east-west direction were introduced, and research was conducted as "special monitoring survey."

The cruise track (main course) for each period and the noon positions of the research base are shown in Fig. 2. The way points (WP) and passing date in the research course are shown in Table 1. The research course consisted of three tracks, one main track established as in the above procedure and two parallel sub-tracks established 6 n.miles apart on both sides. In the special monitoring survey conducted in the second and third periods, the distance between the tracks was set at 4 n.miles considering efficiency of sampling. Three sighting/sampling vessels (*K01*, *T25* and *T18*) were allocated for sighting and sampling activities, with vessels changed each research day.

4. Sighting surveys

Searching was conducted under the similar research conditions as in the IWC/IDCR Southern Hemisphere Minke Whale Assessment Cruise (visibility of 2 n.miles or more and wind velocity 4 or below). Moreover, even when survey conditions were not met, similar searching was carried out under the sea conditions in which collection of whale samples was possible. In this case, an independent research mode (hereinafter referred to as BS mode) was used for data recording in order to distinguish from ordinary sighting surveys (BC mode). Closing was made targeting at minke whales or schools which looked like minke whales. Furthermore, closing was made as much as possible to large whales such as blue, humpback and right whales in order to identify whale species and their school size and conduct the some experiments.

5. Sampling of minke whales

Sampling activities were conducted with the aim to take of 100 minke whales, and were conducted in principle for all the minke whales found during the sighting surveys. Furthermore, sampling effort was conducted whenever it was judged that sampling and biological research were possible even outside the above designated time range, if collection of whale samples was possible. When the schools targeted for sampling were 2 animals or more, numbering was made to all the minke whales in the school, and sampling was made by setting sampling order randomly in accordance with the table of random numbers (Kato *et al.*, 1989). Based on the results of the 1994 research that demonstrated the difficulty to sample targeted whale because minke whales distributed in this area dived for a long time and exhibit a quick mobile behavior (Fujise *et al.*, 1995), the sampling was made in cooperation with three sighting/sampling vessels in this survey.

6. Experiments, observation and oceanographical surveys

On board the sighting/sampling vessels, experiments were conducted on the estimation of distance angle for examination of the precision of sighting data. Also conducted were biopsy sampling experiments on minke whales as well as experiments to install satellite tagging. With respect to blue, humpback and right whales, photographing of natural marks was conducted, and with respect to large whale species, observation of behavior patterns were made. On board the research base, oceanographic observation by means of XBT and marine debris survey were conducted.

## NARRATIVE OF THE RESEARCH

1. First period (13-30 June, 1995)

The research starting point, direction from the starting points, and fixed reflexive angle were

selected randomly. As a result, it was decided to start the research course at 59 degrees from 40°N, 160°23'E (WP1). A 65 degrees angle was selected as the fixed reflexive angle, and in case the reflexive angle is established on both sides at the way point on the boundary, it was selected randomly on each occasion. The first period survey was started at noon, 13 June at the starting point (WP1), and was completed at the ending point (41°38'N, 158°24'E) on 30 June.

2. Second period (1 July - 6 August, 1995)
As many minke whales were found in the southwestern part of the research area (42-43°N, 157-160°E) in the first period, sub-areas were established in the western part (157-163°E) in the second period, and research course was established with emphasis on the longitudinal zones. The method of establishment was as follows:

A. Sub-areas were further divided into zones of two latitudinal degrees.
B. Zigzag research courses were established at an interval of 2 degrees in each longitudinal zone.
C. Research was conducted from the longitudinal zone on the southern side toward the east-west direction, and upon completing it, research on the northern longitudinal zone was made.

However, as the front line extending from low atmospheric pressure lay in east-west direction in the research area, and there was concern that there may be longitudinal zones in which research cannot be implemented under the present research course, the research course was modified on 5 July as follows:

A. Sub-areas were divided into longitudinal zones of 2 degrees on east and west.
B. Zigzag research course was established with an interval of 2 degrees in each longitudinal zone.
C. Research was conducted in the north-south direction along the research course, and upon completion of research of a longitudinal zone, the adjoining longitudinal zone was surveyed.
D. Special monitoring survey was conducted by establishing a separate research course in the east-west direction in accordance with the sea climate information (i.e. concerning gas information and weather charts) as well as the sighting situation of minke whales.

In the second period survey, "sub-area" research was started at the course angle of 159 degrees from WP201 (42°N, 157°E) at 06: 00 on 1 July. The special monitoring survey (SMS) was conducted in each longitudinal zone of 41°N (SMS-A), 42°N (SMS-B), 44°N (SMS-E), 46°N (SMS-C and SMS-D) during the "sub-area" research. The research in the second period was completed at 13:58 on 6 August, when the ending point of the research WP209 (42°N, 161°E) was reached.

3. Third period (7-22 August, 1995)
Research was conducted by establishing a sub-area in the eastern part of the research area (164-169°E). The research course was established in the same way as for the second period. The research in the third period was started at 06:00 on 7 August at the 36 degree course from WP301 (42°N, 166°E). The special monitoring survey was conducted at the 45°N zone (SMS-F) and 47°N zone (SMS-G). The sampling activity was terminated on 15 August because the number of whales sampled reached 100, and only sighting surveys was conducted thereafter.

From 17 August and thereafter, three sighting/sampling vessels were allocated for sighting surveys in the remaining research course and newly added course. The research in the area was completed on 22 August when the ending point (42°N, 160°E) was reached.

## RESULTS

1. Searching distance

The research days for the first, second and third periods were 18, 37 and 16 days, respectively. The total searching distance was 11, 843.9 n.miles (first period: 3,790.9 n.miles, second period: 4,637.3 n.miles, and third period: 3,415.7 n.miles), and 81.8% of the distance were made by BC mode survey.

The searching distance for each period under BC mode survey by one degree is shown in Table 2, and that under BS mode shown in Table 3. In the first period, effort was distributed almost evenly on the research course both under BC and BS modes, without any conspicuous bias, but there were greater efforts at 159°E, where south-north research was made. In the second period, larger efforts were made at 158-160°E and 40°N, 43°N and 45°N, where special monitoring survey was conducted. In the third period, efforts concentrated on 44°N and 166°E. Furthermore, only 11.1 n.miles were covered in the search under BS mode in the third period because no BS mode research was conducted after sampling activities were completed.

2. Distribution of minke whales sighted

Fig. 3 shows the distribution of minke whales and "like minke whales." sighted during the survey. Table 4 shows the whale species sighted during the survey by survey mode and period. Minke whale sighted in the first period were 17 schools/18 animals (primary: 13 schools/13 animals, secondary: 4/5), of which 14 schools (15 animals) were concentrated in the area of 40-42°N, 157-160°E. In the area north of 42°N, although 1,780.3 n.miles were searched under BC mode, only 3 schools (3 animals) of minke whales were found. "Like minke whales" (for which no confirmation was made) were 6 schools/6 animals. In the second period, 96 schools/101 animals were found (primary: 57/57, secondary: 39/44), and the number of "like minke whales" was 6 animals. Minke whales were sighted between 40°N and 46°N, showing a trend that they are distributed northward than in the first period. Minke whales sighted in the third period were 31 schools/32 animals (primary: 20/21, secondary: 11/11), and many were found in 45°N zone and 47°N zone where the special monitoring survey was conducted and 164-166°E.

Tables 5 and 6 show the number of schools of minke whale sighted as primary sighting by searching mode by one degree in the research area. Tables 7 and 8 show the density index (DI: the number of schools found per 100 n.miles searched) by one degree. The primary sighting of minke whales in the first period were made under BC mode for all the 12 schools, except one. The DI for the entire research area in the first period was 0.41 under BC mode and 0.11 under BS mode. High density areas (DI under BC mode: 2.02-3.82) have been formed in the south-western part of the research area (40-41°N, 157°E). In the second period, a total of 48 schools of minke whales were found under BC mode, and the DI was the highest in 45°N zone (2.16-4.10). Furthermore, although 10 schools were found through BS mode, there was no area with a particular high density index. The DI for the entire area in the second period were 1.45 and 0.79 under BC and BS modes, respectively. In the third period, 20 schools of minke whales

were found under BC mode, but no sighting was made through BS mode. The DI was relatively high in the 47°N zone (2.00-6.71), with the DI for the entire research area standing at 0.59. These DI were higher than those in the corresponding period of 1994 (5 July - 6 August, BC mode: 0.82, BS mode: 0.29). The seasonal changes which indicated the highest DI in July (second period) were the same as indicated in the past whale searching boats in the past (June: 0.04, July: 0.30, August: 0.12).

3. Distribution of other whale species sighted

Table 4 shows the number of schools and animals of whales found by searching mode, period and category sighting. Fig. 4 shows the sighting location of large baleen whales in each period. In the first period, large number of large baleen whales were observed in area around WP3 (46-48°N, 160-161°E), with 5 blue, 19 fin, and 12 humpback whales found as primary sightings under BC mode. On the other hand, sperm whales were found around WP2 (44-46°N, 168-170°E), with 69 schools/78 animals primary sightings.

In the second period, 96 sperm, 14 sei, 15 blue and 3 humpback whales were sighted, but there was no such high-density area as that found in the first period . However, there was a tendency for blue, fin and humpback whales to be sighted in the area north of 44°N, and sei whales were found on the southern part of research area. Largest number of *dalli*-type Dall's porpoises (102 schools/458 animals) were found in this period. Pacific white-sided dolphins and northern right whale dolphins were found in the numbers of 11 schools (853 animals) and 6 schools (281 animals), respectively.

In the third period survey, large number of sperm whales (126 schools/140 animals) were sighted, followed by humpback (10/14) and sei whales (6/11). As in the second period, *dalli*-type Dall's porpoises were found more frequently than other dolphins sp. (44 schools/157 animals). Pacific white-sided dolphins and northern right whale dolphins were also found (7 schools 1,180 animals and 10 schools 990 animals , respectively). In this period, a tendency was observed that humpback whales were distributed in the northern part of the research area, and sei and fin whales in the southern part. But no clear tendency of distribution was observed in the blue whales.

4. Sampling of minke whales

A total of 144 schools (151 animals) of minke whales were found throughout the research period, of which sampling was targeted at 131 schools (138 animals), resulting in the catch of 100 minke whales. Table 9 shows the number of minke whales sighted and sampled in each period. There were 38 individuals for which chasing was made for sampling but no catch was made, and the reason for the failure are listed in Table 10. Fig. 5 shows the geographical location of sampled whales.

In the first period, 17 schools/18 animals of minke whales were sighted and targeted (primary: 13 schools/13 animals, secondary: 4 schools/5 animals), resulting in the catch of 14 animals. With respect to the 4 animals that could not be sampled, in two cases the sighting of whales was lost during confirmation, making chasing not possible, and in the another 2 cases, whales were not found in the course of chasing because of long diving and/or quick mobile behaviors.

In the second period, 96 schools/101 animals of minke whales were found, of which sampling was made for 89 schools/94 animals, resulting in the catch of 65 animals. The 29

animals that could not be caught by lost before chasing (15), lost during chasing because of long diving (6), quick mobile behavior (3), deterioration of sea conditions (2) and technical reasons (3).

In the third period, 31 schools/32 animals of minke whales were found, of which sampling activities were directed toward 25 schools/26 animals, resulting in the catch of 21 animals. The 5 animals that could not be caught by lost during chasing because of long diving (2) and quick mobile behavior (3).

Technical sampling efficiency (the rate of sampling of targeted individuals) was 0.78 for the first period, 0.69 for the second and 0.81 for the third, with the rate for the entire research standing at 0.72, which was somewhat lower than the research in the Antarctic (0.85: Nishiwaki *et al.*, 1995). Furthermore, the true sampling efficiency (the percentage of sampled individuals in all the sighted individuals) was 0.78, 0.64, 0.66, respectively, with that for the entire period standing at 0.66.

5. Experiments and oceanographical observations

5.1. *Recording of natural marks*

Photographing of natural marking was made in the range of 3 n.miles in perpendicular distance of trackline, and was implemented to target the blue, humpback and right whales, which were sighted as primary sighting, with due consideration to the research itinerary. Photographing of natural marks was conducted on 7 schools/19 animals of blue whales, 3 schools/5 animals of humpback whales and one right whale.

5.2. *Biopsy sampling experiment*

A total of 7 schools/7 animals of minke whales were targeted for biopsy sampling experiment. Collection of skin biopsy samples was successful for the 3 animals. The time employed for the sampling of individual skin biopsies, ranged from 11 min. to 75 min. It was able to close up to 20 m to the whales getting only one chance of shooting. With respect to the other 4 animals, sample collection was unsuccessful up to one and half hours chasing, with several trials of shooting.

5.3. *Experiment to estimate distance angle*

The experiment was made using the same procedure as in the sighting survey in the North Pacific, and the full-scale experiment was conducted on 30 July after a rehearsal of the experiment on 13 June. However, visibility deteriorated in the course of the experiment, preventing to complete the experiment. Therefore, the remaining part of the experiment was carried out on 4 August. A total of 143 trials were made.

5.4. *Observation of behavior in large whale species*

In the feasibility study in 1994, many large whales such as blue and fin whales were found in the eastern part of the area (Fujise *et al.*, 1995). Therefore, in the case of large whales species such as blue , fin and sperm whales were found, research schedule was adjusted to conduct observation on whale behavior patterns and record their swimming direction, diving time and feeding activities. However, this observation could not conducted because most of whales reacted to the vessels before observation was made. On 18 July, behavior patterns of 3 blue whales in a school, which were found in the primary sighting, were observed for 36 minutes. After the completion of observation, closing was made for the purpose of estimating body length and natural marking photographs were taken. Similar experiments were made on 2

schools/2 animals of sperm whales on 20 August.

5.5. *Experiment to attach satellite marking*
Experiments were made on attaching satellite marking now being performed in the Antarctic on minke whales (Nishiwaki *et al.*, 1995). In the 1995 JARPN survey, it was planned to attach the marking only on one whale in the first half of the research period as a preliminary experiment, with the intention to collect information such as swimming direction and speed. However, experiment were delayed until 23 July because it took time to prepare the device and it was difficult to close up to the sighted schools. Attempt was made for 90 minutes to attach the device on one minke whale. One shooting was made but the attachment failed because the wire connecting the device was broken. Later, a similar attempt was made for 25 minutes to attach the device but did not succeed because there was no chance of shooting.

5.6. *XBT observation*
XBT oceanographic observation and ocean climate observation were conducted at a total of 58 points from 13 June to 17 August on board the research base.

5.7. *Observation of marine debris*
Observation of marine debris was conducted on the bridge of research base for three days (10-12 June) and five days (17-21 August), during the going and return cruises. Observation totaled 104 hours and 30 minutes.

Furthermore, when the debris were found in the stomach contents of the sampled minke whales, they were collected and photographed. During the research period, one or more marine debris were observed in the stomach contents of 10 animals, most of which were plastic covers or their fragments (9 animals), brown-colored glass bottles (1), empty cans (1) and vinyl fragments (1), etc.

6. *Biological research*
Minke whales sampled were retrieved onto the research base and biological researches (measurements and sample collections) were conducted. Table 11 shows major biological research items and the number of animals examined. Items on related to the elucidation of stock structure, such as genetics, morphology, morphometry, osteology, ecology, parasite, pollution and other related items now being surveyed in the Antarctic, were made. In the 1994 research, the presence of *Anisakis* sp. and many other parasites were identified in the North Pacific minke whales and it was expected that the research on parasites would contribute significantly to the elucidation of stock structure of minke whales -- which is the major objective of the present research. Therefore, an parasitologist got on board the fleet in the 1995 research

7. *Products*
After biological sampling was completed, all the whales were processed according to the provisions of Convention, Article VIII. Total production from all of the sampled whales was 316t (Table 12).

8. *Preliminary analysis of biological information*
Data and samples collected during the 1995 surveys are being or were analyzed by experts in each field after the fleet returned to Japan. Preliminary results of biological survey data are presented in this report.

8.1. *Sex ratio and body length*
Values of body length of the sampled individuals are shown in Table 13. Out of 100 minke whales caught, female was only 9 as compared with 91 males. Sex ratio was marked biased toward male in all research periods (first period: 100%, second period: 90.8%, third period: 85.7%). This is result the same as that obtained in 1994.

The average body length of 91 males sampled was 7.38 +/- 0.48m, which indicated no significant changes from that for male in 1994 (7.39 +/- 0.42m). On the other hand, the average body length for female was 7.54 +/- 0.75m, which was larger by 1.1m than in 1994.

8.2. *Blubber thickness and the body girth length*
Table 14 shows the blubber thickness measured below dorsal fin. The average thickness of male blubber was 3.0 +/- 0.5cm (range: 2.2-4.4cm), slightly thinner than that of 1994 (3.5 +/- 0.7cm, range: 2.4-4.8cm, n=18). Notably, it tended to be thinnest for the individuals collected in the first period and second period. On the other hand, the average blubber thickness of female blubber was 3.5 +/- 0.6cm, more or less unchanged from the previous year's values (3.3 +/- 0.3cm in the 1994 research).

Body girth length is shown in Table 15. Here, body girth length means the length of girth radius at the navel. The average body girth length for male was 186+/- 13cm (range: 130 - 216cm), smaller by 13cm than in 1994. The average body girth length for female was 206+/-6 cm (range:190-222cm), larger by 32cm than in the previous year.

8.3. *Fetus size (conception date)*
Seven out of nine females sampled were mature individuals and had fetus. The list of fetuses is shown in Table 16. The body length of the seven fetuses was in the range of 50 to 80 cm, excluding on very small fetus with the length of 9.33cm. The relations between the sampling date and the body length of the fetuses are shown in Fig. 6. All fetuses were considered to have been conceived at roughly the same time as the Okhotsk-Western North Pacific stock ('O' stock).

8.4. *Anomaly in tissues of sampled whales*
Anomaly was found in both (right and left) or either one the reproductive glands (testes and epididymes) in 21 of 91 male whales sampled (Table 17). These showed transformation in part of or entire tissue, and milk-white color purulent matters or those turned into lime were found. The emergence rates in the second and third period were 6.8%, 5.6% for those in which anomalies found on both testes, and when combined with those in which anomalies were found in only one (16.9% and 27.8%, respectively), the emergency rate exceeded 20%. In the 1994 JARPN survey, anomaly was found in only one individual (5.6%) of the 18 male individuals samples. These reproductive glands were preserved in 10% formalin solution for closer examination in later days.

Furthermore, anomalies were detected in whale baleen plates in 3 individuals sampled. Two of them (Nos. 22, 30) had numberless small holes at about 10cm from the gum layer, and in the other individuals (No. 50), part of baleen dropped because of decay of gums, apparently not functioning as baleen.

8.5. *Feeding habit*

Table 18 shows the stomach contents based on conventional classification of the first stomach for 93 individuals, excluding 7 whose first stomach had been destroyed by the harpoon. Throughout the research period, the relative richness of the first stomach was 1 (small quantity: less than 24%) to 2 (to some degree: 49-25%) for many individuals. In the first period, there was no single individual whose stomach was full (4: 100-75%) while in the second period, 16 individuals (25.7%) showed the index of 3 (large: 74-50%) or over. In the third period, majority showed index 1-2, as in the first period, although there were some individuals with full stomach.

Animal plankton such as krill (*Euphausia pacifica*) and pelagic fishes such as Pacific saury (*Cololabis saira*), Japanese anchovy (*Engraulis japonicus*), Japanese sardine (*Sardinops sagaxmelanosticta*), and Pacific pomfret (*Brama japonica*) were identified from observation of stomach contents at the time of biological research. These prey species had been identified also in the 1994 survey. Besides theses species copepods, and other species of fish such as barracuda and pink salmon (*Oncorhynchus gorbuscha*) were newly confirmed (Table 19). Furthermore, Pacific saury was largest in quantity in the prey species confirmed from the stomach contents of sampled minke whales. It was therefore believed that Pacific saury is a major prey species for minke whales in this area.

8.6. *Parasites*

The location examined for parasitological survey were mainly body surface, blubber, stomach, intestines (mainly small intestine), lung (mainly trachea), liver (mainly liver pipe), pancreas (mainly pancreas pipe), kidney (mainly main and urinal route). The locations other than these were examined whenever anomalies were found during the flensing or other sampling activities. The parasites collected are preserved in appropriate ways and will be examined in detail in later days.

Table 20 shows the list of parasites collected from each part of minke whales, and Table 21 shows the parasiting rate. *Anisakis simplex* in the stomach and *Bolbosome* sp. in the small intestine were found in all minke whales sampled. Furthermore, *Trematodae* which were believed to have parasited on liver were also detected from pancreas. Moreover, *Nematodes* were found at the tip of the small intestine (ileo-cecal part), and identified as larvae of *Anisakis simplex* as a result of microscopic observation in later days. Furthermore, in one individual collected in the third period, a large number of whale lice were found all over the stomach.

## DISCUSSIONS

During the research on minke whales in sub-area 9 conducted in 1994, only 21 samples were collected because of poor visibility due to fog and adverse weather condition due to low atmospheric pressures. For this reason, the present research was conducted in sub-area 9 again as the continuation of the 1994 feasibility research, from 13 June to 22 August. The objection to choice the same sub-area was to increase sample size and discuss whether there exist annual fluctuations. Drastically different from 1994, the inflow of warm atmosphere was hampered because of the stay of the front line on the southern part of the research area in 1995. As a result, research was conducted under more favorable weather conditions, resulting in the catch of the targeted number of 100 minke whales. In this report, the characteristics of minke whales distribution in the area are discussed in a comparative point of view with the results of the

1994 research.

Fig. 7 shows the perpendicular distance distribution of minke whales based on sighting angle and distance by searching mode. This figure also shows the cue for sighting. Thanks to favorable weather, 82% of the total searching distance was surveyed by normal survey mode (BC mode). However, the sighting distance of minke whales was largely limited to the range of 1.5 n.miles horizontally as same as in 1994, and the cue was mainly whale body. Furthermore, sighting of 1.5 n.miles or longer was confined to other cue such as jumping. The results coincided with the report of Buckland *et al.* (1992) and may be regarded as the sighting characteristic of minke whales in the North Pacific.

The relationship between sea surface temperature and number of schools of minke whale sighted, is shown in Fig. 8, by research period. Seawater temperature in the first period (June) stayed in the range of 5 to 12°C, and minke whales were found in the southern side of the area, with the most frequent seawater temperature at time of sighting being 12°C. In the second period (early July to early August), the seawater temperature was predominantly 10 to 20°C in the research area. Sightings during this period concentrated in the temperature zone peaking at 13°C. Further, in the third period (mid-August), minke whales were sighted in the water temperature zone of 14-15°C, and the water temperature in which minke whales were found varied in June - August. However, there was no significant changes in the composition of the stomach contents, with Pacific saury being the main feed organism in every period. Comparative examination of the distribution of Pacific saury and minke whales might be necessary. Furthermore, it is should be noted that one of these prey species was pink salmon.

Fig. 9 shows the relationship between estimated body length at the time of sighting of sampled individuals and their actually measured values. Although there are variations between estimated body length and actually measured values, there exist positive correlation and it is possible to estimate roughly the actual size of whale body through estimates of body length. Comparative studies were made on body length composition of the sighted whales and collected whales using the estimated length of minke whales sighted during the sighting surveys (Fig. 10). Although this figure does not include the individuals whose body length could not be estimated, no significant differences are observed in body length composition of sighted whales and sampled whales, maybe suggesting that individuals collected represent the whales distributed in the area. Fig. 11 shows the body length composition of collected samples. This figure also shows the body length composition of whales caught by small-type whaling in the Japanese coastal area and also body length composition obtained in the 1994 research. Body length composition of minke whales in the offshore part of sub-area 9 which was conducted the JARPN surveys in 1995 shows the unimodal distribution with the peak body length of 7.4m for male. This seems to coincide with the peak for large individuals in the Eastern Hokkaido and the area off Sanriku. However, only a small number of small individuals as recognized in the coastal areas have emerged. Furthermore, based on the research on caught individuals, it is considered that a majority of large individuals are mature males and the distribution of immature individuals and mature females was scarce. This may suggest the segregation according to the growth stage in the coastal area and offshore area of Japan. Furthermore, although no sufficient number of samples were obtained to make comparison about female, it is considered from two years of research that females distributed in offshore areas show wide range of body length from 4.8m to 8.2m, and when considered together with male composition, it may be close to body length composition in eastern Hokkaido.

In the 1994 research, *Anisakis simplex* in the stomach and *Bolbosome* sp. in small intestine were detected as internal parasites, but, as parasite experts were onboard the research vessel in 1995, the presence of Cestoda (species unidentified) in 16.0% of minke whales sampled, besides *Anisakis simplex* and *Bolbosome* sp . was identified. Detailed data have not been clarified as regard the number of parasites and parasiting rates, but the presence of 2-3 species of cestoda have been reported in minke whales in the Japanese coastal areas. We have to look toward future analysis for conclusive remark but assumption that the ground for the minke whales in the coastal and offshore areas of Japan differ in terms of stock does not enjoy a strong support, even from the viewpoint of parasite studies.

Furthermore, there have been reports that, based on the research and studies to date, minke whales in the offshore area have the same mtDNA haplotype composition and isozyme composition as that of the Okhotsk Sea-West Pacific stock, mature females have the same conception period with the stock, and that no visible differences were observed in terms of external morphology and accumulation of pollutants. However, three is no adequate sample size for the coastal area which can be adequately compared, except for some studies. Therefore, it is much desired that analysis of data and samples collected in the present research will be made. At the same time, it is much desired that this type of detailed research will be conducted in the Pacific coastal areas of Japan and their results is fully compared and examined.

## ACKNOWLEDGMENTS

The authors present profound appreciation to Dr. Hiroshi Hatanaka, Director-general of the National Research Institute of Far Seas Fisheries, for his guidance in the design and implementation of this research. We are also deeply indebted to the support, cooperation and guidance of Mr. Masayuki Komatsu of the Whaling Section and other officials of the Fisheries Agency, the Government of Japan. In actual implementation, we owed greatly to the guidance and support from Dr. Fukuzo Nagasaki, former Director-general, and Dr. Seiji Ohsumi, Director-general of the Institute of Cetacean Research. We express warm appreciation to all the crew and the staff of the Institute of Cetacean Research and other related institutions who participated in the research. We also thank Dr. Luis A. Pastene for valuable suggestion for preparing of this manuscript. The present covered in this report was funded under the subsidy of the Ministry of Agriculture, Forestry and Fisheries, Government of Japan.

## REFERENCES

Buckland, S.T., Catanach, K.L. and Miyashita, T. 1992. Minke whale abundance in the Northwest Pacific and the Okhotsk Sea, estimated from 1989 and 1990 sighting surveys. *Rep. int. Whal. Commn* 42: 387-92.

Fujise, Y. 1995. Preliminary analysis of heavy metals and organochlorines in minke whales taken from the coastal Japan (sub-area 7) and offshore area (sub-area 9) in the western North Pacific. Paper SC/47/NP5 presented to the IWC Scientific Committee, May 1995 (unpublished). 9pp.

Fujise, Y. and Kato, H. 1995. Preliminary report of morphological differences of minke whales between coastal Japan (sub-area 7) and offshore area (sub-area 9) of western North Pacific. Paper SC/47/NP6 presented to the IWC Scientific Committee, May 1995 (unpublished). 9pp.

Fujise, Y., Kishiro, T., Zenitani, R., Matsuoka, K., Kawasaki, M. and Shimamoto, K. 1995. Cruise report of the Japanese whale research program under a special permit for North Pacific minke whales in 1994. Paper SC/47/NP3 presented to the IWC Scientific Committee, May 1995 (unpublished). 29pp.

Goto, M. and Pastene, L.A. 1995. Population differentiation in the western North Pacific minke whale as revealed by RFLP analysis of mitochondrial D-loop DNA. Paper SC/47/NP4 presented to the IWC Scientific Committee, May 1995 (unpublished). 15pp.

Government of Japan, 1994. Research plan for clarification of minke whale stock structure in the northwestern part of the North Pacific. Paper SC/46/NP1 presented to the IWC Scientific Committee, May 1994 (unpublished). 13pp.+Appledix I-II.

Government of Japan, 1995. The 1995 research plan for the Japanese whale research program under special permit in the northwest part of the North Pacific - continuation of the feasibility study. Paper SC/47/NP1 presented to the IWC Scientific Committee, May 1995 (unpublished). 11pp.

Kato, H. 1992. Body length, reproduction and stock separation of minke whales off Northern Japan. *Rep. int. Whal. Commn* 42:443-53.

Kato, H., Fujise, Y. and Kishiro, T. 1993. Mixing of the two possible stocks of the western North Pacific minke whale, from foetus cohorts. Paper MGWP13 presented to the IWC Scientific Committee, April 1993 (unpublished). 2pp.

Kato, H., Hiroyama, H., Fujise, Y. and Ono, K. 1989. Preliminary report of the 1987/88 Japanese feasibility study of the special permit proposal for Southern Hemisphere minke whales. *Rep. Int. Whal. Commn* 39: 235-48.

Kuramochi, T., Machida, M., Araki, J., Uchida, A., Kishiro, T. and Nagasawa, K. 1995. Minke whales (*Balaenoptera acutorostrata*) are one of the major final hosts of *Anisakis simplex* (Nematoda: Anisakidae) in the northwestern North Pacific Ocean. Paper SC/47/NP8 presented to the IWC Scientific Committee, May 1995 (unpublished). 10pp.

Nishiwaki, S., Ishikawa, H., Itoh, S., Shimamoto, K., Mogoe, T., Kawazu, H., Machida, S., Yamane, T., Ono, K. and Ohkoshi, C. 1995. Report of the 1994/95 cruise of the Japanese whale research programme under special permit (JARPA) in the Antarctic Area V. Paper SC/47/SH15 presented to the IWC Scientific Committee, May 1995 (unpublished). 38pp.

Wada, S. 1995. Comparison of allele frequencies between minke whale samples from Japanese coastal waters and pelagic waters (subarea 9). Paper SC/47/NP7 presented to the IWC Scientific Committee, May 1995 (unpublished). 4pp.

Table 1. Summary of cruise track of the JARPN survey in 1995

| Stratum | Way point | | Course direction | Distance (n. miles) | Date |
|---|---|---|---|---|---|
| First period | WP1 | 40°00'N, 160°23'E | 59 | 500.5 | 6 June |
| 6-30 June | WP2 | 44°18'N, 170°00'E | 304 | 457.8 | 17 June |
| | WP3 | 48°34'N, 160°51'E | 189 | 520.4 | 22 June |
| | WP4 | 40°00'N, 158°57'E | 304 | 107.5 | 28 June |
| | WP5 | 41°00'N, 157°00'E | 59 | 73.8 | 29 June |
| | WP6 | 41°38'N, 158°24'E | | | 30 June |
| Second Period | WP201 | 42°00'N, 157°00'E | 159 | 128.2 | 1 July |
| 1 July- | WP202 | 40°00'N, 158°00'E | 21 | 128.2 | 3 July |
| 6 August | WP203 | 42°00'N, 159°00'E | 323 | 148.8 | 9 July |
| | WP204 | 44°00'N, 157°00'E | 35 | 147.1 | 16 July |
| | WP205 | 46°00'N, 159°00'E | 19 | 126.9 | 19 July |
| | WP206 | 48°00'N, 160°00'E | 161 | 126.9 | 20 July |
| | WP207 | 46°00'N, 161°00'E | 215 | 147.1 | 21 July |
| | WP208 | 44°00'N, 159°00'E | | | 28 July |
| SMS-A | WP-A1 | 40°40'N, 159°00'E | 270 | 57.1 | 6 July |
| 6-8 July | WP-A2 | 40°40'N, 157°45'E | 360 | 10 | 6 July |
| | WP-A3 | 40°50'N, 157°45'E | 90 | 56.9 | 6 July |
| | WP-A4 | 40°50'N, 158°18'E | | | |
| | WP-A5 | 40°40'N, 159°00'E | 90 | 53.3 | 7 July |
| | WP-A6 | 40°40'N, 160°10'E | 360 | 15 | 7 July |
| | WP-A7 | 40°55'N, 160°10'E | 270 | 53.1 | 7 July |
| | WP-A8 | 40°55'N, 158°28'E | | | 8 July |
| SMS-B | WP-B1 | 42°05'N, 158°35'E | 270 | 59.6 | 10 July |
| 10-15 July | WP-B2 | 42°05'N, 157°15'E | 180 | 15 | 10 July |
| | WP-B3 | 41°50'N, 157°15'E | 90 | 190.6 | 11 July |
| | WP-B4 | 41°50'N, 161°30'E | 360 | 15 | 12 July |
| | WP-B5 | 42°05'N, 161°30'E | 270 | 108 | 13 July |
| | WP-B6 | 42°05'N, 159°05'E | 180 | 65 | 13 July |
| | WP-B7 | 41°00'N, 159°05'E | 270 | 15.1 | 14 July |
| | WP-B8 | 41°00'N, 158°45'E | 360 | 60 | 14 July |
| | WP-B9 | 42°00'N, 158°45'E | | | 15 July |
| SMS-C | WP-C1 | 45°00'N, 158°20'E | 90 | 17.7 | 17 July |
| 17 July | WP-C2 | 45°00'N, 158°45'E | 360 | 15 | 17 July |
| | WP-C3 | 45°05'N, 157°50'E | | | |
| SMS-D | WP-D1 | 45°20'N, 160°00'E | 270 | 91.7 | 22 July |
| 22-27 July | WP-D2 | 45°20'N, 157°50'E | 180 | 15 | 22 July |
| | WP-D3 | 45°05'N, 157°50'E | 90 | 163 | 23 July |
| | WP-D4 | 45°05'N, 161°40'E | 360 | 15 | 26 July |
| | WP-D5 | 45°20'N, 161°40'E | 270 | 56.4 | 26 July |
| | WP-D6 | 45°20'N, 160°20'E | | | 27 July |
| SMS-E | WP-E1 | 44°00'N, 159°20'E | 90 | 101 | 29 July |
| 29 July - | WP-E2 | 44°00'N, 161°40'E | 180 | 15 | 1 August |
| 5 August | WP-E3 | 43°45'N, 161°40'E | 270 | 159.5 | 2 August |
| | WP-E4 | 43°45'N, 158°00'E | 360 | 15 | 3 August |
| | WP-E5 | 44°00'N, 158°00'E | 90 | 43.3 | 5 August |
| | WP-E6 | 44°00'N, 159°00'E | | | 5 August |

SMS: Special monitaring survey

Table 1. (continued)

| Stratum | Way point | | Course direction | Distance (n. miles) | Date |
|---|---|---|---|---|---|
| Third period | WP301 | 42°00'N, 166°00'E | 36 | 148.8 | 7 August |
| 8-16 August | WP302 | 44°00'N, 168°00'E | 324 | 147.1 | 8 August |
| | WP303 | 46°00'N, 166°00'E | 34 | 71.3 | 9 August |
| | WP304 | 46°59'N, 166°58'E | 326 | 143.8 | 16 August |
| SMS-F | WP-F1 | 45°00'N, 166°40'E | 270 | 113.5 | 9 August |
| 9-13 August | WP-F2 | 45°00'N, 164°00'E | 180 | 15 | 10 August |
| | WP-F3 | 44°45'N, 164°00'E | 90 | 213.8 | 10 August |
| | WP-F4 | 44°45'N, 169°00'E | 360 | 15 | 12 August |
| | WP-F5 | 45°00'N, 169°00'E | 270 | 78.1 | 12 August |
| | WP-F6 | 45°00'N, 167°10'E | | | 13 August |
| SMS-G | WP-G1 | 47°00'N, 166°40'E | 270 | 89 | 14 August |
| 14-16 August | WP-G2 | 47°00'N, 164°30'E | 180 | 15 | 15 August |
| | WP-G3 | 46°45'N, 164°30'E | 90 | 75.6 | 16 August |
| | WP-G4 | 46°45'N, 166°20'E | | | 16 August |
| SS-K01 | WP401 | 49°00'N, 167°00'E | 326 | 71.6 | 17 August |
| 17-22 August | WP402 | 50°00'N, 166°00'E | 319 | 59.1 | 18 August |
| | WP403 | 50°45'N, 165°00'E | 220 | 59.1 | 18 August |
| | WP404 | 50°00'N, 164°00'E | 146 | 143.8 | 19 August |
| | WP405 | 48°00'N, 166°00'E | 214 | 145.5 | 20 August |
| | WP406 | 46°00'N, 164°00'E | | | 21 August |
| SS-T25 | WP501 | 46°59'N, 166°58'E | 34 | 74.1 | 17 August |
| 17-22 August | WP502 | 48°00'N, 168°00'E | 326 | 72.1 | 17 August |
| | WP503 | 49°00'N, 167°00'E | 270 | 158 | 17 August |
| | WP504 | 49°00'N, 163°00'E | 146 | 72.1 | 19 August |
| | WP505 | 48°00'N, 164°00'E | 214 | 145.5 | 19 August |
| | WP506 | 46°00'N, 162°00'E | 144 | 147.1 | 20 August |
| | WP507 | 44°00'N, 164°00'E | 216 | 148.8 | 21 August |
| | WP508 | 42°00'N, 162°00'E | | | 22 August |
| SS-T18 | WP601 | 46°45'N, 166°20'E | 90 | 110 | 17 August |
| 17-22 August | WP602 | 46°45'N, 169°00'E | 360 | 15 | 17 August |
| | WP603 | 47°00'N, 169°00'E | 282 | 291 | 17 August |
| | WP604 | 48°00'N, 162°00'E | 214 | 145.5 | 18 August |
| | WP605 | 46°00'N, 160°00'E | 144 | 147.1 | 20 August |
| | WP606 | 44°00'N, 162°00'E | 216 | 148.8 | 21 August |
| | WP607 | 42°00'N, 160°00'E | | | 22 August |

SMS: Special monitaring survey, SS: Sighting survey by single vessel

Table 2. Searching distances (n. miles) of BC mode survey by one degree and research period

First period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0.0 |
| 50°N | | | | | | | | | | | | | | 0.0 |
| 49°N | | | | | | | | | | | | | | 0.0 |
| 48°N | | | | 71.2 | 124.5 | | | | | | | | | 195.7 |
| 47°N | | | | 117.8 | | 8.0 | 32.0 | 17.9 | | | | | | 175.7 |
| 46°N | | | | 64.1 | | | | 2.2 | | | | | | 66.3 |
| 45°N | | | | | | | | | | 25.0 | 135.5 | 82.8 | | 243.3 |
| 44°N | | | 88.2 | 20.5 | | | | | | | | 46.8 | 247.2 | 402.7 |
| 43°N | | | 174.9 | | | | | | | 11.6 | 106.4 | 147.9 | 46.6 | 487.4 |
| 42°N | | | 179.5 | | | | | 1.4 | 11.2 | 3.7 | 13.4 | | | 209.2 |
| 41°N | 131.0 | 50.7 | 158.5 | | | 25.3 | 41.8 | 89.5 | | | | | | 496.8 |
| 40°N | 148.8 | 212.7 | 112.5 | 69.4 | 41.2 | 45.4 | | | | | | | | 630.0 |
| Total | 279.8 | 263.4 | 713.6 | 343.0 | 165.7 | 78.7 | 73.8 | 111.0 | 11.2 | 40.3 | 255.3 | 277.5 | 293.8 | 2,907.1 |

Second period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0.0 |
| 50°N | | | | | | | | | | | | | | 0.0 |
| 49°N | | | | | | | | | | | | | | 0.0 |
| 48°N | | | | | | | | | | | | | | 0.0 |
| 47°N | | | 28.2 | 35.5 | | | | | | | | | | 63.7 |
| 46°N | | 10.0 | 125.3 | 52.6 | 9.1 | | | | | | | | | 197.0 |
| 45°N | 73.7 | 219.3 | 211.8 | 288.2 | 92.5 | | | | | | | | | 885.5 |
| 44°N | | 72.1 | 82.5 | 81.8 | 34.7 | | | | | | | | | 271.1 |
| 43°N | 9.4 | 95.3 | 245.7 | 120.2 | 129.2 | | | | | | | | | 599.8 |
| 42°N | 44.0 | 13.9 | 10.7 | 195.9 | 13.0 | | | | | | | | | 277.5 |
| 41°N | 63.3 | 157.9 | 145.6 | | 0.9 | | | | | | | | | 367.7 |
| 40°N | 158.6 | 262.2 | 205.1 | 86.3 | | | | | | | | | | 712.2 |
| Total | 349.0 | 830.7 | 1,054.9 | 860.5 | 279.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3,374.5 |

Third period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | |
| 50°N | | | | | | | | 14.1 | 33.3 | | | | | 47.4 |
| 49°N | | | | | | | | 29.5 | | | | | | 29.5 |
| 48°N | | | | | | | 7.1 | | 29.3 | | | | | 36.4 |
| 47°N | | | | | | | 20.2 | 29.8 | 99.8 | 22.7 | | | | 172.5 |
| 46°N | | | | 47.8 | | 63.0 | | 143.6 | 151.9 | 257.2 | 3.1 | | | 666.6 |
| 45°N | | | | 72.8 | 0.5 | 73.3 | 0.3 | 77.3 | 83.8 | 240.5 | 58.5 | 53.1 | 13.3 | 673.4 |
| 44°N | | | | | 72.5 | | 50.9 | 190.6 | 130.6 | 167.2 | 331.8 | 165.4 | 30.6 | 1,139.6 |
| 43°N | | | | 0.5 | 21.2 | | | | | 13.2 | 183.7 | | | 218.6 |
| 42°N | | | | 161.4 | 55.8 | 7.6 | | | 6.5 | 178.3 | 11.0 | | | 420.6 |
| 41°N | | | | | | | | | | | | | | 0.0 |
| 40°N | | | | | | | | | | | | | | 0.0 |
| Total | 0.0 | 0.0 | 0.0 | 282.5 | 150.0 | 143.9 | 78.5 | 484.9 | 535.2 | 879.1 | 588.1 | 218.5 | 43.9 | 3,404.6 |

Table 3. Searching distances (n. miles) of BS mode survey by one degree and research period

First period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0.0 |
| 50°N | | | | | | | | | | | | | | 0.0 |
| 49°N | | | | | | | | | | | | | | 0.0 |
| 48°N | | | | 20.2 | 4.1 | | | | | | | | | 24.3 |
| 47°N | | | | 36.0 | | 31.1 | 35.1 | 7.6 | | | | | | 109.8 |
| 46°N | | | | | | | | 62.0 | 31.7 | | | | | 93.7 |
| 45°N | | | 30.7 | 40.0 | | | | | | 12.0 | | | | 82.7 |
| 44°N | | | 40.3 | 21.9 | | | | | | | | | | 62.2 |
| 43°N | | | | | | | | | | | 5.2 | | | 5.2 |
| 42°N | | | 2.4 | | | | | 35.0 | 79.2 | 120.9 | 1.8 | | | 239.3 |
| 41°N | | | 15.4 | | | 43.7 | 64.2 | 29.6 | 2.1 | | | | | 155.0 |
| 40°N | | | | 19.8 | 47.6 | 44.2 | | | | | | | | 111.6 |
| Total | 0.0 | 0.0 | 88.8 | 137.9 | 51.7 | 119.0 | 99.3 | 134.2 | 113.0 | 132.9 | 7.0 | 0.0 | 0.0 | 883.8 |

Second period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0.0 |
| 50°N | | | | | | | | | | | | | | 0.0 |
| 49°N | | | | | | | | | | | | | | 0.0 |
| 48°N | | | | | | | | | | | | | | 0.0 |
| 47°N | | | 56.1 | 79.0 | | | | | | | | | | 135.1 |
| 46°N | | 13.0 | 30.2 | 80.7 | | | | | | | | | | 123.9 |
| 45°N | | 79.7 | 15.1 | 0.9 | 55.1 | | | | | | | | | 150.8 |
| 44°N | 34.3 | 8.8 | 73.6 | 0.0 | 17.4 | | | | | | | | | 134.1 |
| 43°N | 36.3 | 85.2 | 71.8 | 45.3 | 14.0 | | | | | | | | | 252.6 |
| 42°N | 33.5 | 150.1 | 1.3 | 2.7 | 13.5 | | | | | | | | | 201.1 |
| 41°N | 114.3 | 58.3 | 11.1 | | | | | | | | | | | 183.7 |
| 40°N | 19.9 | 35.2 | 26.4 | | | | | | | | | | | 81.5 |
| Total | 238.3 | 430.3 | 285.6 | 208.6 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,262.8 |

Third period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0.0 |
| 50°N | | | | | | | | | | | | | | 0.0 |
| 49°N | | | | | | | | | | | | | | 0.0 |
| 48°N | | | | | | | | | | | | | | 0.0 |
| 47°N | | | | | | | | | | | | | | 0.0 |
| 46°N | | | | | | | | | | | | | | 0.0 |
| 45°N | | | | | | | | | | | | | | 0.0 |
| 44°N | | | | | | | | | | | 10.9 | | | 10.9 |
| 43°N | | | | | | | | | | | 0.2 | | | 0.2 |
| 42°N | | | | | | | | | | | | | | 0.0 |
| 41°N | | | | | | | | | | | | | | 0.0 |
| 40°N | | | | | | | | | | | | | | 0.0 |
| Total | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 11.1 | 0.0 | 0.0 | 11.1 |

| | Searching mode * | | | | |
|---|---|---|---|---|---|
| | BC mode | | BS mode | | OE |
| | Primary | Secondary. | Primary | Secondary. | Secondary |
| **First period** | | | | | |
| Minke whale | 12 / 12 | 2 / 3 | 1 / 1 | - | 2 / 2 ** |
| Like minke whale | 3 / 3 | 2 / 2 | - | 1 / 1 | - |
| Blue whale | 2 / 5 | - | - | - | - |
| Fin whale | 9 / 12 | - | - | - | - |
| Humpback whale | 9 / 19 | 1 / 4 | - | - | - |
| Right whale | - | - | - | - | 1 / 1 |
| Sperm whale | 55 / 64 | 2 / 2 | 14 / 14 | 1 / 1 | 2 / 2 |
| Killer whale | 11 / 38 | 2 / 12 | 3 / 6 | - | - |
| Cuvier's beaked whale | 2 / 3 | - | - | - | - |
| Unidentified Mesoplodon | 15 / 39 | - | 1 / 2 | - | 1 / 3 |
| Unidentified Ziphiidae | 13 / 23 | - | 3 / 7 | - | 1 / 1 |
| Dall's porpoise | | | | | |
| dalli type | 61 / 284 | 3 / 16 | 12 / 77 | 1 / 6 | 4 / 19 |
| Unidentified type | 33 / 191 | 2 / 30 | 5 / 22 | - | 1 / 2 |
| Pacific white-sided dolphin | 2 / 140 | - | - | - | - |
| Right whale dolphin | 3 / 70 | - | - | - | - |
| Unidentified large cetacean | 3 / 3 | 5 / 13 | 1 / 1 | - | - |
| Unidentified small cetacean | 120 / 825 | 10 / 49 | 5 / 45 | 4 / 17 | 4 / 18 |
| Unidentified cetacean | 20 / 24 | 4 / 5 | 3 / 3 | - | 1 / 1 |
| **Second period** | | | | | |
| Minke whale | 48 / 48 | 19 / 19 | 9 / 9 | 2 / 2 | 18 / 23 ** |
| Like minke whale | 1 / 1 | 2 / 2 | - | 1 / 1 | 2 / 2 |
| Blue whale | 4 / 12 | 1 / 1 | 1 / 1 | - | 1 / 1 |
| Fin whale | 5 / 8 | - | - | - | - |
| Sei whale | 6 / 7 | 2 / 2 | 1 / 1 | - | 3 / 4 |
| Humpback whale | 1 / 1 | - | 2 / 2 | - | - |
| Sperm whale | 51 / 64 | 14 / 14 | 7 / 7 | - | 11 / 11 |
| Killer whale | 9 / 33 | 1 / 5 | 2 / 6 | - | - |
| Cuvier's beaked whale | 1 / 2 | - | - | - | 1 / 3 |
| Unidentified Mesoplodon | 2 / 5 | 1 / 4 | 2 / 4 | - | 1 / 1 |
| Unidentified Ziphiidae | 35 / 81 | 10 / 26 | 7 / 11 | - | - |
| Dall's porpoise | | | | | |
| dalli type | 54 / 235 | 7 / 29 | 16 / 66 | 3 / 19 | 22 / 109 |
| Unidentified type | 39 / 200 | 7 / 24 | 19 / 83 | - | 10 / 27 |
| Pacific white-sided dolphin | 5 / 180 | 1 / 400 | 3 / 240 | - | 2 / 33 |
| Right whale dolphin | 3 / 170 | - | 3 / 111 | - | - |
| Unidentified large cetacean | 10 / 11 | 1 / 1 | 1 / 1 | - | 2 / 2 |
| Unidentified small cetacean | 136 / 1,250 | 15 / 71 | 18 / 69 | 9 / 50 | 9 / 65 |
| Unidentified cetacean | 36 / 38 | 12 / 13 | 13 / 13 | 3 / 3 | 3 / 3 |
| **Third period** | | | | | |
| Minke whale | 20 / 21 | 7 / 7 | - | - | 4 / 4 ** |
| Like minke whale | - | - | - | - | 1 / 1 |
| Blue whale | - | - | - | - | 3 / 4 |
| Fin whale | 4 / 4 | - | - | - | - |
| Sei whale | 5 / 9 | - | - | - | 1 / 2 |
| Humpback whale | 8 / 11 | 1 / 1 | - | - | 1 / 2 |
| Right whale | 1 / 1 | - | - | - | - |
| Sperm whale | 116 / 129 | 6 / 6 | - | - | 4 / 5 |
| Killer whale | 17 / 80 | 2 / 14 | - | - | - |
| Cuvier's beaked whale | - | - | - | - | - |
| Unidentified Mesoplodon | 3 / 8 | - | - | - | - |
| Unidentified Ziphiidae | 48 / 89 | 4 / 7 | - | - | 2 / 2 |
| Dall's porpoise | | | | | |
| dalli type | 36 / 134 | 5 / 15 | - | - | 3 / 8 |
| black type | 1 / 1 | - | - | - | - |
| Unidentified type | 54 / 219 | 3 / 19 | - | - | 2 / 6 |
| Pacific white-sided dolphin | 6 / 930 | - | - | - | 1 / 250 |
| Right whale dolphin | 9 / 940 | - | - | - | 1 / 50 |
| Risso's dolphin | 1 / 8 | - | - | - | - |
| Unidentified large cetacean | 6 / 7 | 1 / 1 | - | - | 1 / 1 |
| Unidentified small cetacean | 105 / 1,372 | 8 / 83 | - | - | 2 / 6 |
| Unidentified cetacean | 26 / 26 | 8 / 8 | - | - | 1 / 1 |

*: See text

**: including secondary sightings (1/1 in the first period, 10/14 in the second period and 3/3 in the third period) by the research base.

Table 5. Distribution of primary sighting of minke whale by BC mode searching by one degree

A. School base

First period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | | | | | | | 0 |
| 49°N | | | | | | | | | | | | | | 0 |
| 48°N | | | | 0 | 0 | 0 | | | | | | | | 0 |
| 47°N | | | | 1 | | | 0 | 0 | | | | | | 1 |
| 46°N | | | | 0 | | | | 0 | | | | | | 0 |
| 45°N | | | | | | | | | | 0 | 0 | 0 | | 0 |
| 44°N | | | 0 | 0 | | | | | | | | 0 | 1 | 1 |
| 43°N | | | 0 | | | | | | | 0 | 0 | 0 | 0 | 0 |
| 42°N | | | 0 | | | | | 0 | 0 | 0 | 0 | | | 0 |
| 41°N | 5 | 0 | 1 | | | 0 | 0 | 0 | | | | | | 6 |
| 40°N | 3 | 1 | 0 | 0 | 0 | 0 | | | | | | | | 4 |
| Total | 8 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 12 |

Second period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | | | | | | | 0 |
| 49°N | | | | | | | | | | | | | | 0 |
| 48°N | | | | | | | | | | | | | | 0 |
| 47°N | | | | | | | | | | | | | | 0 |
| 46°N | | | | | | | | | | | | | | 0 |
| 45°N | 2 | 9 | 6 | 7 | 2 | | | | | | | | | 26 |
| 44°N | | | | 1 | | | | | | | | | | 1 |
| 43°N | | | 1 | 3 | | | | | | | | | | 4 |
| 42°N | 3 | | | | | | | | | | | | | 3 |
| 41°N | | 3 | 1 | | | | | | | | | | | 4 |
| 40°N | 2 | 4 | 2 | 2 | | | | | | | | | | 10 |
| Total | 7 | 16 | 10 | 13 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 |

Third period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | 0 | 0 | | | | | 0 |
| 49°N | | | | | | | | 0 | | | | | | 0 |
| 48°N | | | | | | | 0 | | 0 | | | | | 0 |
| 47°N | | | | | | | 0 | 2 | 2 | 1 | | | | 5 |
| 46°N | | | | 0 | | 0 | | 2 | 1 | 1 | 0 | | | 4 |
| 45°N | | | | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 3 |
| 44°N | | | | | 0 | | 0 | 2 | 1 | 0 | 1 | 1 | 0 | 5 |
| 43°N | | | | 0 | 0 | | | | | 0 | 0 | | | 0 |
| 42°N | | | | 0 | 1 | 0 | | | 0 | 2 | 0 | | | 3 |
| 41°N | | | | | | | | | | | | | | 0 |
| 40°N | | | | | | | | | | | | | | 0 |
| Total | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 8 | 4 | 5 | 1 | 1 | 0 | 20 |

B. individual base

First period

| | Longitude | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | | | | | | | 0 |
| 49°N | | | | | | | | | | | | | | 0 |
| 48°N | | | | | | | | | | | | | | 0 |
| 47°N | | | | 1 | | | | | | | | | | 1 |
| 46°N | | | | | | | | | | | | | | 0 |
| 45°N | | | | | | | | | | | | | | 0 |
| 44°N | | | | | | | | | | | | | 1 | 1 |
| 43°N | | | | | | | | | | | | | | 0 |
| 42°N | | | | | | | | | | | | | | 0 |
| 41°N | 5 | | 1 | | | | | | | | | | | 6 |
| 40°N | 3 | 1 | | | | | | | | | | | | 4 |
| Total | 8 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 12 |

Second period

| | Longitude | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | | | | | | | 0 |
| 49°N | | | | | | | | | | | | | | 0 |
| 48°N | | | | | | | | | | | | | | 0 |
| 47°N | | | | | | | | | | | | | | 0 |
| 46°N | | | | | | | | | | | | | | 0 |
| 45°N | 2 | 9 | 6 | 7 | 2 | | | | | | | | | 26 |
| 44°N | | | | 1 | | | | | | | | | | 1 |
| 43°N | | | 1 | 3 | | | | | | | | | | 4 |
| 42°N | 3 | | | | | | | | | | | | | 3 |
| 41°N | | 3 | 1 | | | | | | | | | | | 4 |
| 40°N | 2 | 4 | 2 | 2 | | | | | | | | | | 10 |
| Total | 7 | 16 | 10 | 13 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 |

Third period

| | Longitude | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | 0 | 0 | | | | | 0 |
| 49°N | | | | | | | | 0 | | | | | | 0 |
| 48°N | | | | | | | 0 | | 0 | | | | | 0 |
| 47°N | | | | | | | 0 | 2 | 2 | 1 | | | | 5 |
| 46°N | | | | 0 | | 0 | | 2 | 1 | 1 | 0 | | | 4 |
| 45°N | | | | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 3 |
| 44°N | | | | | 0 | | 0 | 2 | 1 | 0 | 1 | 2 | 0 | 6 |
| 43°N | | | | 0 | 0 | | | | | 0 | 0 | | | 0 |
| 42°N | | | | 0 | 1 | 0 | | | 0 | 2 | 0 | | | 3 |
| 41°N | | | | | | | | | | | | | | 0 |
| 40°N | | | | | | | | | | | | | | 0 |
| Total | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 8 | 4 | 5 | 1 | 2 | 0 | 21 |

Table 6. Distribution of primary sighting of minke whale by BS mode searching by one degree

A. School base

First period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | | | | | | | 0 |
| 49°N | | | | | | | | | | | | | | 0 |
| 48°N | | | | 0 | 0 | | | | | | | | | 0 |
| 47°N | | | | 0 | | 0 | 0 | 0 | | | | | | 0 |
| 46°N | | | | | | | | 0 | 0 | | | | | 0 |
| 45°N | | | 0 | 0 | | | | | | 0 | | | | 0 |
| 44°N | | | 0 | 0 | | | | | | | | | | 0 |
| 43°N | | | | | | | | | | | 0 | | | 0 |
| 42°N | | | 0 | | | | | 0 | 0 | 0 | 0 | | | 0 |
| 41°N | | | 1 | | | 0 | 0 | 0 | 0 | | | | | 1 |
| 40°N | | | | 0 | 0 | 0 | | | | | | | | 0 |
| Total | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

Second period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | | | | | | | 0 |
| 49°N | | | | | | | | | | | | | | 0 |
| 48°N | | | | | | | | | | | | | | 0 |
| 47°N | | | | | | | | | | | | | | 0 |
| 46°N | | | | | | | | | | | | | | 0 |
| 45°N | | | | | | | | | | | | | | 0 |
| 44°N | | | 1 | | | | | | | | | | | 1 |
| 43°N | 2 | | | 1 | 1 | | | | | | | | | 4 |
| 42°N | 2 | | | | | | | | | | | | | 2 |
| 41°N | 1 | | | | | | | | | | | | | 1 |
| 40°N | | 1 | | | | | | | | | | | | 1 |
| Total | 5 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |

Third period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | | | | | | | 0 |
| 49°N | | | | | | | | | | | | | | 0 |
| 48°N | | | | | | | | | | | | | | 0 |
| 47°N | | | | | | | | | | | | | | 0 |
| 46°N | | | | | | | | | | | | | | 0 |
| 45°N | | | | | | | | | | | | | | 0 |
| 44°N | | | | | | | | | | | 0 | | | 0 |
| 43°N | | | | | | | | | | | 0 | | | 0 |
| 42°N | | | | | | | | | | | | | | 0 |
| 41°N | | | | | | | | | | | | | | 0 |
| 40°N | | | | | | | | | | | | | | 0 |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

B. individual base

First period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | | | | | | | 0 |
| 49°N | | | | | | | | | | | | | | 0 |
| 48°N | | | | | | | | | | | | | | 0 |
| 47°N | | | | | | | | | | | | | | 0 |
| 46°N | | | | | | | | | | | | | | 0 |
| 45°N | | | | | | | | | | | | | | 0 |
| 44°N | | | | | | | | | | | | | | 0 |
| 43°N | | | | | | | | | | | | | | 0 |
| 42°N | | | | | | | | | | | | | | 0 |
| 41°N | | | 1 | | | | | | | | | | | 1 |
| 40°N | | | | | | | | | | | | | | 0 |
| Total | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

Second period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | | | | | | | 0 |
| 49°N | | | | | | | | | | | | | | 0 |
| 48°N | | | | | | | | | | | | | | 0 |
| 47°N | | | | | | | | | | | | | | 0 |
| 46°N | | | | | | | | | | | | | | 0 |
| 45°N | | | | | | | | | | | | | | 0 |
| 44°N | | | 1 | | | | | | | | | | | 1 |
| 43°N | 2 | | | 1 | 1 | | | | | | | | | 4 |
| 42°N | 2 | | | | | | | | | | | | | 2 |
| 41°N | 1 | | | | | | | | | | | | | 1 |
| 40°N | | 1 | | | | | | | | | | | | 1 |
| Total | 5 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |

Third period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0 |
| 50°N | | | | | | | | | | | | | | 0 |
| 49°N | | | | | | | | | | | | | | 0 |
| 48°N | | | | | | | | | | | | | | 0 |
| 47°N | | | | | | | | | | | | | | 0 |
| 46°N | | | | | | | | | | | | | | 0 |
| 45°N | | | | | | | | | | | | | | 0 |
| 44°N | | | | | | | | | | | 0 | | | 0 |
| 43°N | | | | | | | | | | | 0 | | | 0 |
| 42°N | | | | | | | | | | | | | | 0 |
| 41°N | | | | | | | | | | | | | | 0 |
| 40°N | | | | | | | | | | | | | | 0 |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 7. Density indicies (no. of schools/100 n. miles) of minke whales by BC mode searching by one degree.

First period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0.00 |
| 50°N | | | | | | | | | | | | | | 0.00 |
| 49°N | | | | | | | | | | | | | | 0.00 |
| 48°N | | | | 0.00 | 0.00 | | | | | | | | | 0.00 |
| 47°N | | | | 0.85 | | 0.00 | 0.00 | 0.00 | | | | | | 0.57 |
| 46°N | | | | 0.00 | | | | 0.00 | | | | | | 0.00 |
| 45°N | | | | | | | | | | 0.00 | 0.00 | 0.00 | | 0.00 |
| 44°N | | | 0.00 | 0.00 | | | | | | | | 0.00 | 0.40 | 0.25 |
| 43°N | | | 0.00 | | | | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42°N | | | 0.00 | | | | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 |
| 41°N | 3.82 | 0.00 | 0.63 | | | 0.00 | 0.00 | 0.00 | | | | | | 1.21 |
| 40°N | 2.02 | 0.47 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | | | 0.63 |
| Total | 2.86 | 0.38 | 0.14 | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.41 |

Second period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0.00 |
| 50°N | | | | | | | | | | | | | | 0.00 |
| 49°N | | | | | | | | | | | | | | 0.00 |
| 48°N | | | | | | | | | | | | | | 0.00 |
| 47°N | | | 0.00 | 0.00 | | | | | | | | | | 0.00 |
| 46°N | | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | | | | 0.00 |
| 45°N | 2.71 | 4.10 | 2.83 | 2.43 | 2.16 | | | | | | | | | 2.94 |
| 44°N | | 0.00 | 0.00 | 1.22 | 0.00 | | | | | | | | | 0.37 |
| 43°N | 0.00 | 0.00 | 0.41 | 2.50 | 0.00 | | | | | | | | | 0.67 |
| 42°N | 6.82 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | | | | 1.08 |
| 41°N | 0.00 | 2.53 | 0.69 | | 0.00 | | | | | | | | | 1.36 |
| 40°N | 1.26 | 1.53 | 0.98 | 2.32 | | | | | | | | | | 1.40 |
| Total | 2.01 | 2.05 | 0.95 | 1.51 | 0.72 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.45 |

Third period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0.00 |
| 50°N | | | | | | | | 0.00 | 0.00 | | | | | 0.00 |
| 49°N | | | | | | | | 0.00 | | | | | | 0.00 |
| 48°N | | | | | | | 0.00 | | 0.00 | | | | | 0.00 |
| 47°N | | | | | | | 0.00 | 6.71 | 2.00 | 4.41 | | | | 2.90 |
| 46°N | | | | 0.00 | | 0.00 | | 1.39 | 0.66 | 0.39 | 0.00 | | | 0.60 |
| 45°N | | | | 0.00 | 0.00 | 0.00 | 0.00 | 2.59 | 0.00 | 0.42 | 0.00 | 0.00 | 0.00 | 0.45 |
| 44°N | | | | | 0.00 | | 0.00 | 1.05 | 0.77 | 0.00 | 0.30 | 0.60 | 0.00 | 0.44 |
| 43°N | | | | 0.00 | 0.00 | | | | | 0.00 | 0.00 | | | 0.00 |
| 42°N | | | | 0.00 | 1.79 | 0.00 | | | 0.00 | 1.12 | 0.00 | | | 0.71 |
| 41°N | | | | | | | | | | | | | | 0.00 |
| 40°N | | | | | | | | | | | | | | 0.00 |
| Total | 0.00 | 0.00 | 0.00 | 0.00 | 0.67 | 0.00 | 0.00 | 1.65 | 0.75 | 0.57 | 0.17 | 0.46 | 0.00 | 0.59 |

Table 8. Density indicies (no. of schools/100 n. miles) of minke whales by BS mode searching by one degree.

First period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0.00 |
| 50°N | | | | | | | | | | | | | | 0.00 |
| 49°N | | | | | | | | | | | | | | 0.00 |
| 48°N | | | | 0.00 | 0.00 | | | | | | | | | 0.00 |
| 47°N | | | | 0.00 | | 0.00 | 0.00 | 0.00 | | | | | | 0.00 |
| 46°N | | | | | | | | 0.00 | 0.00 | | | | | 0.00 |
| 45°N | | | 0.00 | 0.00 | | | | | | 0.00 | | | | 0.00 |
| 44°N | | | 0.00 | 0.00 | | | | | | | | | | 0.00 |
| 43°N | | | | | | | | | | | 0.00 | | | 0.00 |
| 42°N | | | 0.00 | | | | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 |
| 41°N | | | 6.49 | | | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.65 |
| 40°N | | | | 0.00 | 0.00 | 0.00 | | | | | | | | 0.00 |
| Total | 0.00 | 0.00 | 1.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 |

Second period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | 0.00 |
| 50°N | | | | | | | | | | | | | | 0.00 |
| 49°N | | | | | | | | | | | | | | 0.00 |
| 48°N | | | | | | | | | | | | | | 0.00 |
| 47°N | | | 0.00 | 0.00 | | | | | | | | | | 0.00 |
| 46°N | | 0.00 | 0.00 | 0.00 | | | | | | | | | | 0.00 |
| 45°N | | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | | | | 0.00 |
| 44°N | 0.00 | 0.00 | 1.36 | | 0.00 | | | | | | | | | 0.75 |
| 43°N | 5.51 | 0.00 | 0.00 | 2.21 | 7.14 | | | | | | | | | 1.58 |
| 42°N | 5.97 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | | | | 0.99 |
| 41°N | 0.87 | 0.00 | 0.00 | | | | | | | | | | | 0.54 |
| 40°N | 0.00 | 5.68 | 0.00 | | | | | | | | | | | 2.45 |
| Total | 2.10 | 0.46 | 0.35 | 0.48 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.79 |

Third period

| | Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 157°E | 158°E | 159°E | 160°E | 161°E | 162°E | 163°E | 164°E | 165°E | 166°E | 167°E | 168°E | 169°E | Total |
| 51°N | | | | | | | | | | | | | | |
| 50°N | | | | | | | | | | | | | | 0.00 |
| 49°N | | | | | | | | | | | | | | 0.00 |
| 48°N | | | | | | | | | | | | | | 0.00 |
| 47°N | | | | | | | | | | | | | | 0.00 |
| 46°N | | | | | | | | | | | | | | 0.00 |
| 45°N | | | | | | | | | | | | | | 0.00 |
| 44°N | | | | | | | | | | | 0.00 | | | 0.00 |
| 43°N | | | | | | | | | | | 0.00 | | | 0.00 |
| 42°N | | | | | | | | | | | | | | 0.00 |
| 41°N | | | | | | | | | | | | | | 0.00 |
| 40°N | | | | | | | | | | | | | | 0.00 |
| Total | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 9. Numbers of minke whales sighted and sampled by the sighting/sighting vessels and their sampling efficiencies

| Period | Sighted | | Targeted | | Sampled | Sampling efficiencies | |
|---|---|---|---|---|---|---|---|
| | Sch. (A) | Ind. (B) | Sch. (C) | Ind. (D) | Ind. (E) | Technical (F/D) | True (F/B) |
| First | 17 | 18 | 17 | 18 | 14 | 0.78 | 0.78 |
| Second | 96 | 101 | 89 | 94 | 65 | 0.69 | 0.64 |
| Third | 31 | 32 | 25 | 26 | 21 | 0.81 | 0.66 |
| Total | 144 | 151 | 131 | 138 | 100 | 0.72 | 0.66 |

Table 10. Cause of failure to collect samples targeted by research period. A: long diving; B: quick/mobile behavior; C: rough sea condition; D: technical problems; E: missing of the targeted animal before chasing; F: other

| Period | Reason why whales could not be sampled | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | |
| First | 1 | 1 | 0 | 0 | 1 | 1 | 4 |
| Second | 6 | 3 | 2 | 3 | 15 | 0 | 29 |
| Third | 2 | 3 | 0 | 0 | 0 | 0 | 5 |
| Combined | 9 | 7 | 2 | 3 | 16 | 1 | 38 |

Table 11. Summary of biological data and samples collected

| Samples and data | Number of whales | | |
|---|---|---|---|
| | Male | Female | Total |
| Body length and sex | 91 | 9 | 100 |
| External body proportion | 91 | 9 | 100 |
| Photographic record and external character | 91 | 9 | 100 |
| Diatom film record and sampling | 91 | 9 | 100 |
| Standard measurements of blubber thickness (three points) | 91 | 9 | 100 |
| Detailed measurements of blubber thickness | 26 | 3 | 29 |
| Body weight | 91 | 9 | 100 |
| Body weight by parts | 26 | 3 | 29 |
| Blubber, muscle, liver and heart tissues for DNA study | 91 | 9 | 100 |
| Muscle, liver and heart tissues for isozyme analysis | 91 | 9 | 100 |
| Muscle, liver and kidney tissues for heavy metal analysis | 91 | 9 | 100 |
| Blubber, muscle, liver and kidney tissues for organochlorine analysis | 91 | 9 | 100 |
| Tissues for lipid analysis | 26 | 3 | 29 |
| Muscle, liver, limpa and intestine tissue for bacteria study | 26 | 3 | 29 |
| Mammary grand; lactation status, measurements and histological sample | - | 9 | 9 |
| Ovary collection | - | 9 | 9 |
| Uterine horn; measurement and endometrium sample | - | 9 | 9 |
| Uterine mucus for sperm detection | - | 9 | 9 |
| Photographic record of fetus | - | - | 7 |
| Fetal sex (identified by visual observation) | (2) | (5) | (7) |
| Fetal length and weight | (2) | (5) | (7) |
| External measurements of fetus | (2) | (4) | (6) |
| Collection of fetus | (2) | (5) | (7) |
| Testis and epididymis; weight and histlogical sample | 91 | - | 91 |
| Smear samples from testis and epididymis tissues | 91 | - | 91 |
| Urine sample for sperm detection | 77 | - | 77 |
| Urine sample for physiological study | 85 | 8 | 93 |
| Serum sample for physiological study | 91 | 9 | 100 |
| Stomach content, conventional record | 91 | 9 | 100 |
| Weight of stomach content in each compartment | 91 | 9 | 100 |
| Collection of stomach contents for the food and feeding study | 90 | 8 | 98 |
| Collection of stomach contents for organochlorine analysis | | | |
| Collection of stomach contents for heavy metal analysis | 15 | 2 | 17 |
| Collection of stomach contents for lipid analysis | 10 | 1 | 11 |
| Collection of external parasites | 23 | 3 | 26 |
| Collection of parasites from 1st stomach | 1 | 0 | 1 |
| Collection of parasites from 2nd stomach | 90 | 7 | 97 |
| Collection of parasites from 3rd stomach | 42 | 5 | 47 |
| Collection of parasites from 4th stomach | 12 | 2 | 14 |
| Collection of parasites from intestine | 20 | 3 | 23 |
| Collection of parasites from liver | 8 | 1 | 9 |
| Earplug for age determination | 91 | 9 | 100 |
| Tympanic bulla for age determination | 91 | 9 | 100 |
| Largest baleen plate for stock identification | 91 | 9 | 100 |
| Vertebral ephiphyses sample | 91 | 9 | 100 |
| Skull measurement (length and breadth) | 91 | 9 | 100 |
| Detailed measurement of skull | 2 | 3 | 5 |
| Detailed measurement of skull and skeleton | 0 | 1 | 1 |
| Collection of skull | 0 | 1 | 1 |

Table 12. Products amassed at the research base in the 1995 JARPN survey.

| Name of product | Amount (kg) | Name of product | Amount (kg) |
|---|---|---|---|
| O-niku* | 135 | Throat mottled meat | 1,769 |
| O-niku* (regular) | 450 | Bacon (grade 1) | 11,988 |
| Ventral blubber (neck) | 75 | Bacon (grade 2) | 14 |
| Jaw skin (mottled) | 345 | Bacon (small pieces) | 4,050 |
| Jaw skin (regular) | 255 | Ventral blubber | 1,134 |
| Red meat (premium) | 1,215 | Blubber (premium) | 0 |
| Red meat (grade 1) | 64,140 | Blubber (grade 1) | 19,630 |
| Red meat (grade 2) | 8,760 | Kidney | 742 |
| Red meat (regular) | 1,965 | Heart | 1,008 |
| Small pieces (grade 1) | 12,510 | Pancreas | 189 |
| Small pieces (grade 2) | 6,930 | Esophagus | 169 |
| Small pieces (regular) | 11,910 | Mandibular ligaments (hard) | 429 |
| Breast meat (grade 1) | 14,205 | Mandibular ligaments (soft) | 247 |
| Breast meat (grade 2) | 32,820 | Tongue (mottled) | 507 |
| Breast meat (grade 3) | 61,335 | Tongue | 3,705 |
| Breast meat (regular) | 870 | Tongue (regular) | 0 |
| Diaphragm | 1,320 | First stomach | 468 |
| Blubber (regular) | 13,125 | Intestine | 0 |
| Posterior ventral blubber | 15,300 | Underside of blubber | 4,325 |
| Nasal plug | 700 | Lining of meat | 3,225 |
| Tail flukes (premium) | 4,475 | Testis | 72 |
| Tail flukes (regular) | 775 | Caudal tendon | 840 |
| Maxillary cartilage | 300 | Tendon | 7,770 |

*: Muscles associated with caudal vertebra.

Table1 3. Mean body length of minke whales taken in the JARPN surveys in 1994 and 1995

| | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Range | n | Mean | S.D. | Range | n |
| 1994 survey | | | | | | | | |
| First (5 July-6 Aug.) | 7.42 | ± 0.19 | ( 7.21 - 7.70 ) | 6 | 5.93 | | ( 4.79 - 7.07 ) | 2 |
| Second (7 Aug.-7 Sept.) | 7.37 | ± 0.50 | ( 6.12 - 8.09 ) | 12 | 7.55 | | | 1 |
| Total | 7.39 | ± 0.42 | ( 6.12 - 8.09 ) | 18 | 6.47 | ± 1.20 | ( 4.79 - 7.55 ) | 3 |
| 1995 survey | | | | | | | | |
| First (13-30 June) | 7.25 | ± 0.56 | ( 5.91 - 7.95 ) | 14 | | | | 0 |
| Second (1 July-6 Aug.) | 7.47 | ± 0.34 | ( 6.59 - 8.40 ) | 59 | 7.88 | ± 0.26 | ( 7.45 - 8.18 ) | 6 |
| Third (7-15 Aug.) | 7.21 | ± 0.68 | ( 4.54 - 7.66 ) | 18 | 6.87 | ± 0.93 | ( 5.73 - 8.01 ) | 3 |
| Total | 7.38 | ± 0.48 | ( 4.54 - 8.40 ) | 91 | 7.54 | ± 0.75 | ( 5.73 - 8.18 ) | 9 |

Table1 4. Mean blubber thichness (cm) of minke whales taken in the JARPN surveys in 1994 and 1995

| | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Range | n | Mean | S.D. | Range | n |
| 1994 survey | | | | | | | | |
| First | 3.5 | ± 0.9 | ( 2.7 - 4.8 ) | 6 | 3.1 | | ( 2.9 - 3.3 ) | 2 |
| Second | 3.5 | ± 0.5 | ( 2.4 - 4.3 ) | 12 | 3.6 | | | 1 |
| Total | 3.5 | ± 0.7 | ( 2.4 - 4.8 ) | 18 | 3.3 | ± 0.3 | ( 2.9 - 3.6 ) | 3 |
| 1995 survey | | | | | | | | |
| First | 2.9 | ± 0.5 | ( 2.3 - 4.4 ) | 14 | | | | 0 |
| Second | 2.9 | ± 0.4 | ( 2.2 - 4.1 ) | 59 | 3.6 | ± 0.6 | ( 2.9 - 4.3 ) | 6 |
| Third | 3.4 | ± 0.5 | ( 2.4 - 4.4 ) | 18 | 3.2 | ± 0.7 | ( 2.5 - 4.1 ) | 3 |
| Total | 3.0 | ± 0.5 | ( 2.2 - 4.4 ) | 91 | 3.5 | ± 0.6 | ( 2.5 - 4.3 ) | 9 |

Table1 5. Mean half of girth (cm) at umbilicus of minke whales taken in the JARPN survey in 1944 and 1995

| | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Range | n | Mean | S.D. | Range | n |
| 1994 survey | | | | | | | | |
| First | 198 | ± 9 | ( 183 - 209 ) | 6 | 162 | | ( 131 - 193 ) | 2 |
| Second | 199 | ± 17 | ( 174 - 232 ) | 12 | 199 | | | 1 |
| Total | 199 | ± 15 | ( 174 - 232 ) | 18 | 174 | ± 31 | ( 131 - 199 ) | 3 |
| 1995 survey | | | | | | | | |
| First | 182 | ± 13 | ( 159 - 200 ) | 14 | | | | 0 |
| Second | 186 | ± 11 | ( 166 - 216 ) | 58 | 209 | ± 7 | ( 203 - 222 ) | 5 |
| Third | 186 | ± 17 | ( 130 - 206 ) | 17 | 197 | ± 7 | ( 190 - 203 ) | 2 |
| Total | 186 | ± 13 | ( 130 - 216 ) | 89 | 206 | ± 9 | ( 190 - 222 ) | 7 |

Table1 6. Summary of pregnant females and her fetus collected in this survey

| Sampling Date | Sample No. | Body length (m) | Blubber thickness (cm) | Fetus | | |
|---|---|---|---|---|---|---|
| | | | | Length (cm) | Weight (kg) | Sex |
| 6 July | 18 | 8.02 | 4.2 | 61.4 | 3.0 | M |
| 22 July | 48 | 7.60 | 3.4 | 9.3 | 0.02 | F |
| 23 July | 57 | 7.45 | 4.3 | 79.7 | 6.33 | F |
| 24 July | 58 | 8.05 | 2.9 | 55.6 | 2.62 | F |
| 25 July | 71 | 7.95 | 3.0 | 49.6 | 1.8 | F |
| 1 August | 76 | 8.18 | 3.9 | 76.8 | 6.3 | F |
| 9 August | 86 | 8.01 | 3.0 | 73.8 | 5.8 | M |

Table 17. Number of male whales observed abnormal in his gonadal tissues

| Survey and research period | n | Normal | Abnormal | | | |
|---|---|---|---|---|---|---|
| | | | Both side | (%) | One side | (%) |
| 1994 survey | | | | | | |
| First (5 July-6 Aug.) | 6 | 5 | 0 | ( 0.0 ) | 1 | ( 16.7 ) |
| Second (7 Aug.-7 Sept.) | 12 | 12 | 0 | ( 0.0 ) | 0 | ( 0.0 ) |
| Total | 18 | 17 | 0 | ( 0.0 ) | 1 | ( 5.6 ) |
| 1995 survey | | | | | | |
| First (13-30 June) | 14 | 13 | 0 | ( 0.0 ) | 1 | ( 7.1 ) |
| Second (1 July-6 Aug.) | 59 | 45 | 4 | ( 6.8 ) | 10 | ( 16.9 ) |
| Third (7-15 Aug.) | 18 | 12 | 1 | ( 5.6 ) | 5 | ( 27.8 ) |
| Total | 91 | 70 | 5 | ( 5.5 ) | 16 | ( 17.6 ) |

Table 18. Composition of relative richness of stomach contents based on conventional classification by the research period

| Period | Relative richness (%) | | | | | |
|---|---|---|---|---|---|---|
| | Empty | < 25% | 25-49% | 50-74% | 75-100% | Total |
| First | 0 ( 0.0% ) | 10 ( 71.4% ) | 4 ( 28.6% ) | 0 ( 0.0% ) | 0 ( 0.0% ) | 14 |
| Second | 5 ( 7.9% ) | 24 ( 38.1% ) | 18 ( 28.6% ) | 15 ( 23.8% ) | 1 ( 1.6% ) | 63 |
| Third | 0 ( 0.0% ) | 8 ( 50.0% ) | 6 ( 37.5% ) | 1 ( 6.3% ) | 1 ( 6.3% ) | 16 |

Table19. Food species of minke whale and their frequency of occurence by survey period

| Food species | | First | | Second | | Third | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | n | (%) | n | (%) | n | (%) | n | (%) |
| Euphausiacea | Euphausiids | 1 | ( 7.1 ) | 10 | ( 14.7 ) | 1 | ( 5.6 ) | 12 | ( 12.0 ) |
| Copepoda | copepods | 0 | ( 0.0 ) | 2 | ( 2.9 ) | 2 | ( 11.1 ) | 4 | ( 4.0 ) |
| Salmonids | Pink salmon (*Oncorhynchus gorbuscha*) | 2 | ( 14.3 ) | 7 | ( 10.3 ) | 0 | ( 0.0 ) | 9 | ( 9.0 ) |
| | Unidentified | 1 | ( 7.1 ) | 0 | ( 0.0 ) | 1 | ( 5.6 ) | 2 | ( 2.0 ) |
| Sauries | Pacific saury (*Cololabis saira*) | 4 | ( 28.6 ) | 58 | ( 85.3 ) | 13 | ( 72.2 ) | 75 | ( 75.0 ) |
| Anchovies | Japanese anchovy (*Engraulis japonicus*) | 3 | ( 21.4 ) | 4 | ( 5.9 ) | 1 | ( 5.6 ) | 8 | ( 8.0 ) |
| Herrings | Japanese sardine (*Sardinops melanostictus*) | 1 | ( 7.1 ) | 0 | ( 0.0 ) | 0 | ( 0.0 ) | 1 | ( 1.0 ) |
| | Unidentified | 4 | ( 28.6 ) | 3 | ( 4.4 ) | 0 | ( 0.0 ) | 7 | ( 7.0 ) |
| Barracudas | Unidentified | 0 | ( 0.0 ) | 1 | ( 1.5 ) | 0 | ( 0.0 ) | 1 | ( 1.0 ) |
| Pomfrets | Pacific pomfret (*Brama japonica*) | 0 | ( 0.0 ) | 1 | ( 1.5 ) | 3 | ( 16.7 ) | 4 | ( 4.0 ) |
| Daggertooths | Daggertooth (*Anotopterus pharao*) | 1 | ( 7.1 ) | 0 | ( 0.0 ) | 0 | ( 0.0 ) | 1 | ( 1.0 ) |
| Other fishes | Unidenfitied | 0 | ( 0.0 ) | 1 | ( 1.5 ) | 2 | ( 11.1 ) | 3 | ( 3.0 ) |

Table 2 0. List of parasites in minke whales observed

| Position | Parasite |
|---|---|
| Skin | Pennella (Crustacea, Copepoda) |
| | Lepas (Crustacea, Cirripadia) |
| | Cyamus (Crustacea, Amphipoda) |
| Blubber | - (part of pennella) |
| Stomach | Nematode (*Anisakis simplex*) |
| Small intestine | Acanthocephala (genus: *Bolbosoma*) |
| | Cestoda (at least 3 species in *Pseudophyllidea* and *Cyclophyllidea*) |
| Lung | - |
| Liver | Trematoda (*Lecithodesmus*) |
| Pancreas | Trematoda (*Lecithodesmus*) |
| Kidney | - |

Table 2 1. Observation rate of parasitic worm in minke whale taken in the JARPN survey in 1995

| Parasitic worm | Body part | First | | Second | | Third | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Infected/ exmained | % | Infected/ exmained | % | Infected/ exmained | % | Infected/ exmained | % |
| **External parasite** | | | | | | | | | |
| Pennella | Skin | 12 / 14 | 92.9 | 48 / 65 | 73.8 | 18 / 21 | 85.7 | 78 / 100 | 78.0 |
| Cirripadia | Skin | 0 / 14 | 0.0 | 4 / 65 | 6.2 | 0 / 21 | 0.0 | 4 / 100 | 4.0 |
| Cyamus | Skin | 0 / 14 | 0.0 | 3 / 65 | 4.6 | 1 / 21 | 4.8 | 4 / 100 | 4.0 |
| **Internal parasite** | | | | | | | | | |
| Nematode | Stomach | 14 / 14 | 100.0 | 65 / 65 | 100.0 | 21 / 21 | 100.0 | 100 / 100 | 100.0 |
| Nematode | Intestine (ileo-cecal part) | - - - | – | 10 / 45 | 22.2 | 1 / 21 | 4.8 | 11 / 66 | 16.7 |
| Acanthocephala | Small intestine | 14 / 14 | 100.0 | 65 / 65 | 100.0 | 21 / 21 | 100.0 | 100 / 100 | 100.0 |
| Cestoda | | 3 / 14 | 21.4 | 7 / 65 | 10.8 | 6 / 21 | 28.6 | 16 / 100 | 16.0 |
| Trematoda | Liver | 3 / 14 | 21.4 | 31 / 65 | 47.7 | 3 / 21 | 14.3 | 37 / 100 | 37.0 |
| Trematoda | Pancreas | 0 / 14 | 0.0 | 1 / 65 | 1.5 | 0 / 21 | 0.0 | 1 / 100 | 1.0 |

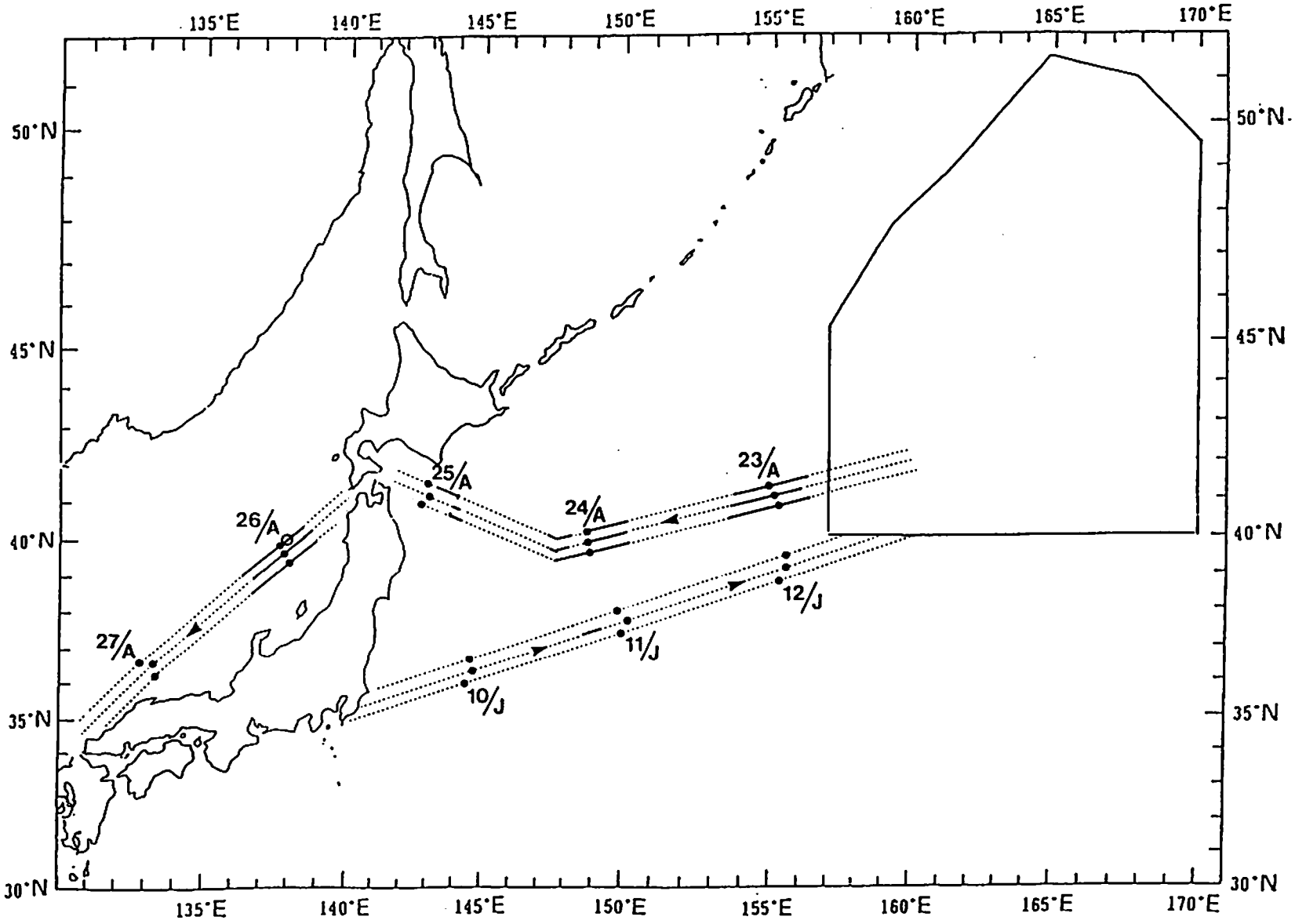


Fig. 1. Geographic location of research area and cruise tracks of sighting survey associated with the 1995 JARPN survey. Closed circles represent the noon positions of three sampling/sighting vessels, solid line indicate the survey conducted, and open circle sighting of minke whale.

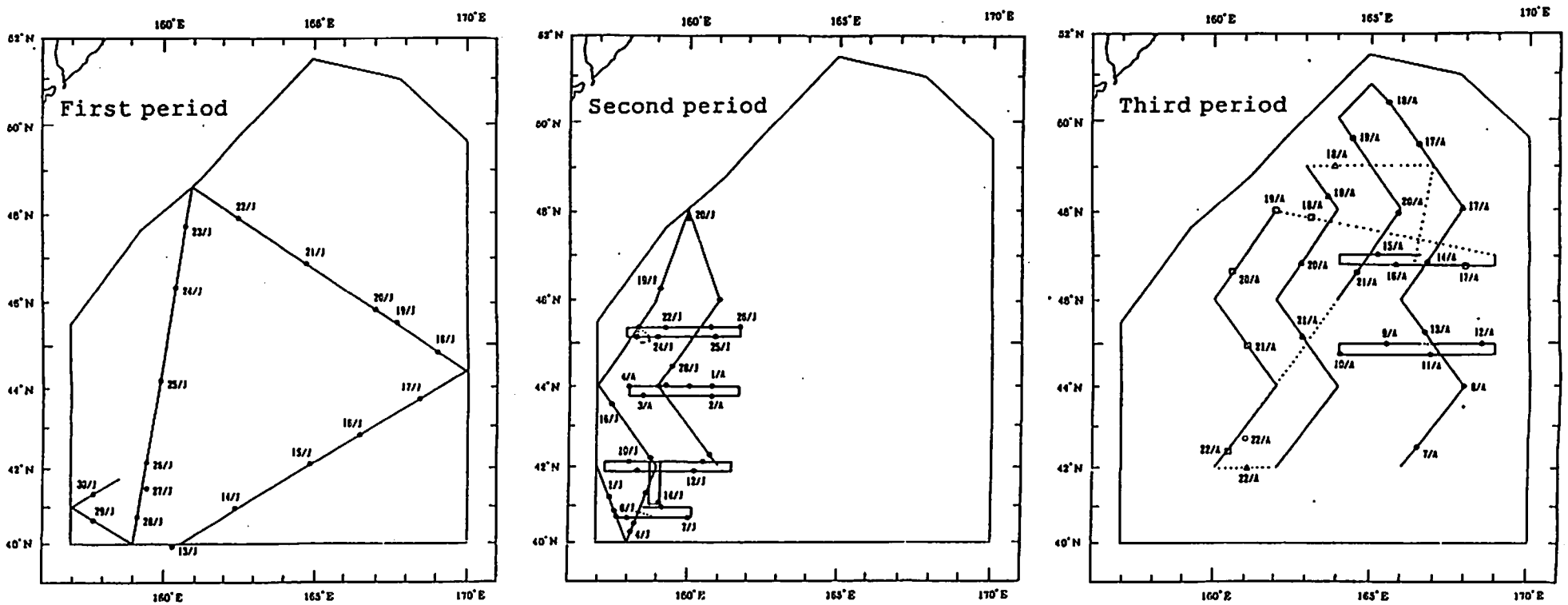


Fig. 2. Cruise track indicating the noon position of the research base (NM: ● ) for the JARPN survey in 1995. Figure also shows the noon positions of three sighting/sampling vessels (K01: ○, T25: △, T18: □) after the sampling activities were completed (from 17 August to 22 August).

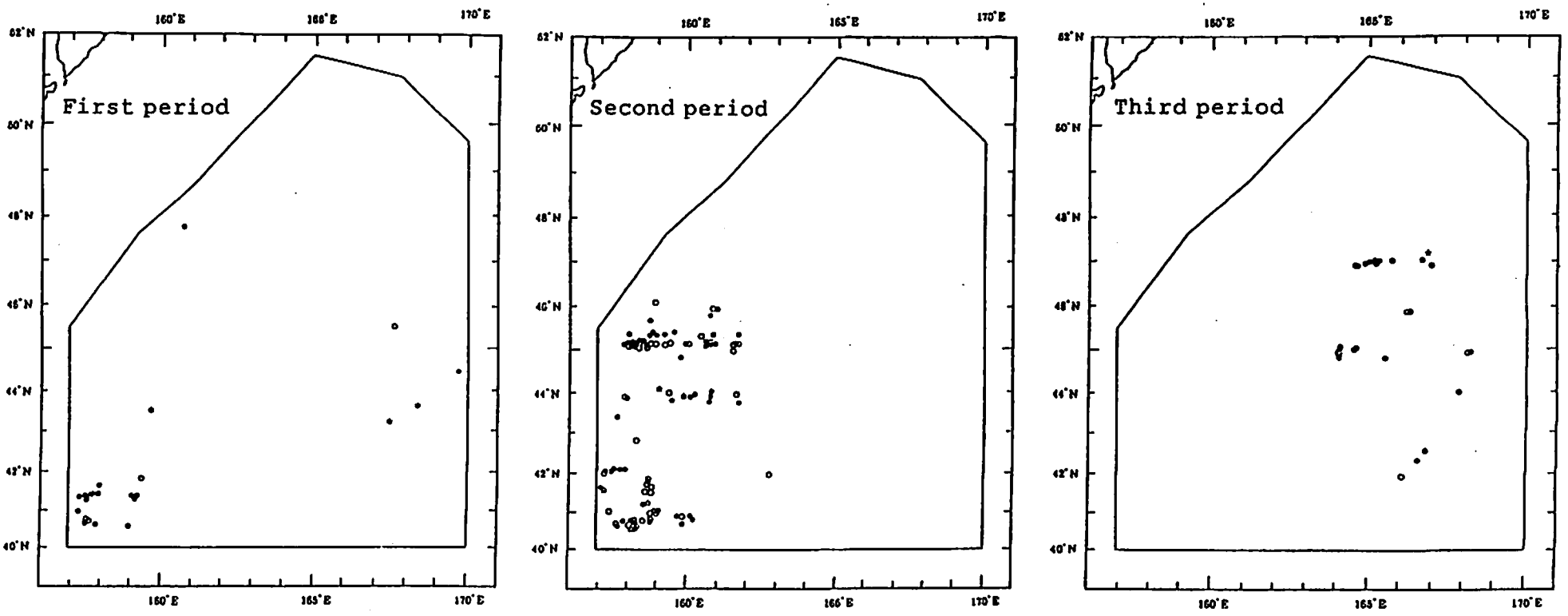


Fig. 3. Distribution of minke whales sighted by three sampling/sighting vessels during the 1995 JARPN. Confirmed minke whale: ● primary, ○ secondary; like minke whale: ✻ primary, ☆ secondary.

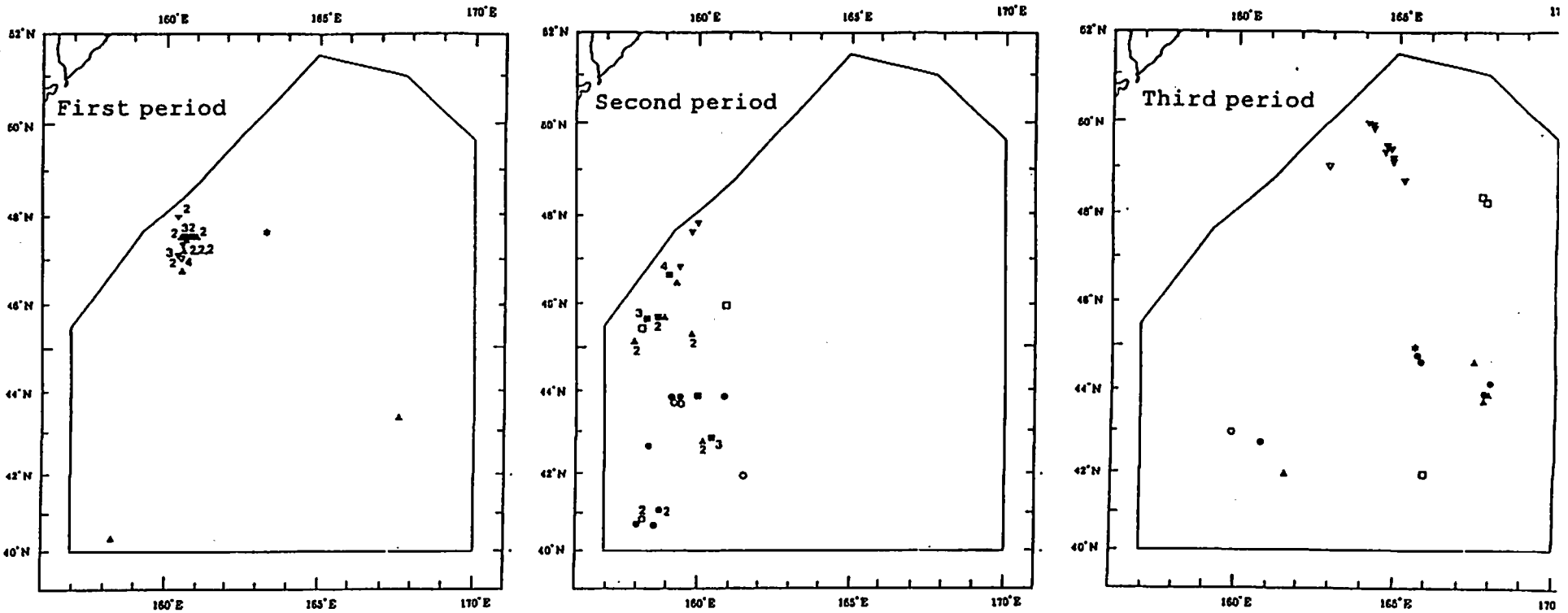


Fig. 4. Distribution of blue, fin, humpback, sei and right whales sighted by three sighting/sampling vessels. Numeral in figure indicates the school size.
Blue whale: ■ primary, □ secondary; Fin whale: ▲ primary, △ secondary;
Humpback whale: ▼ primary, ▽ secondary; Sei whale: ● primary, ○ secondary;
Right whale: ✻ primary.

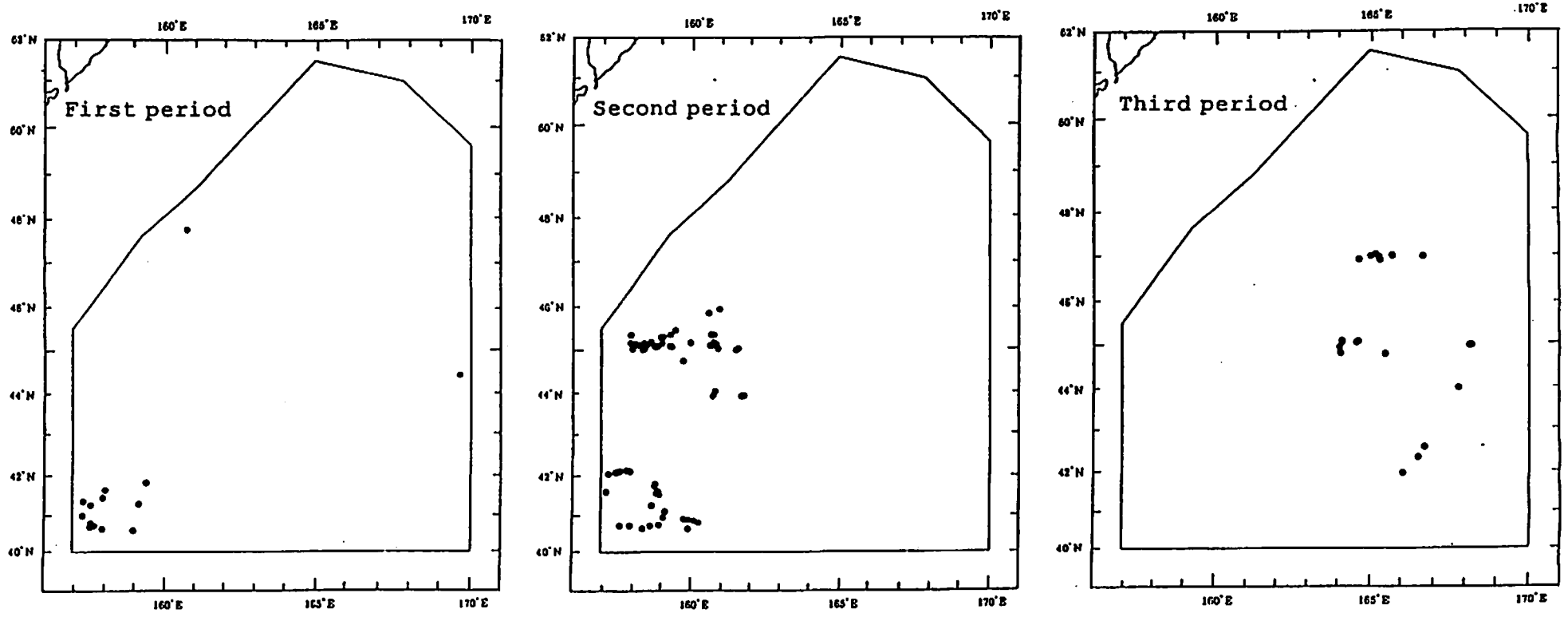


Fig. 5. Distribution of minke whales sampled during the 1995 JARPN, based on their sighting position.

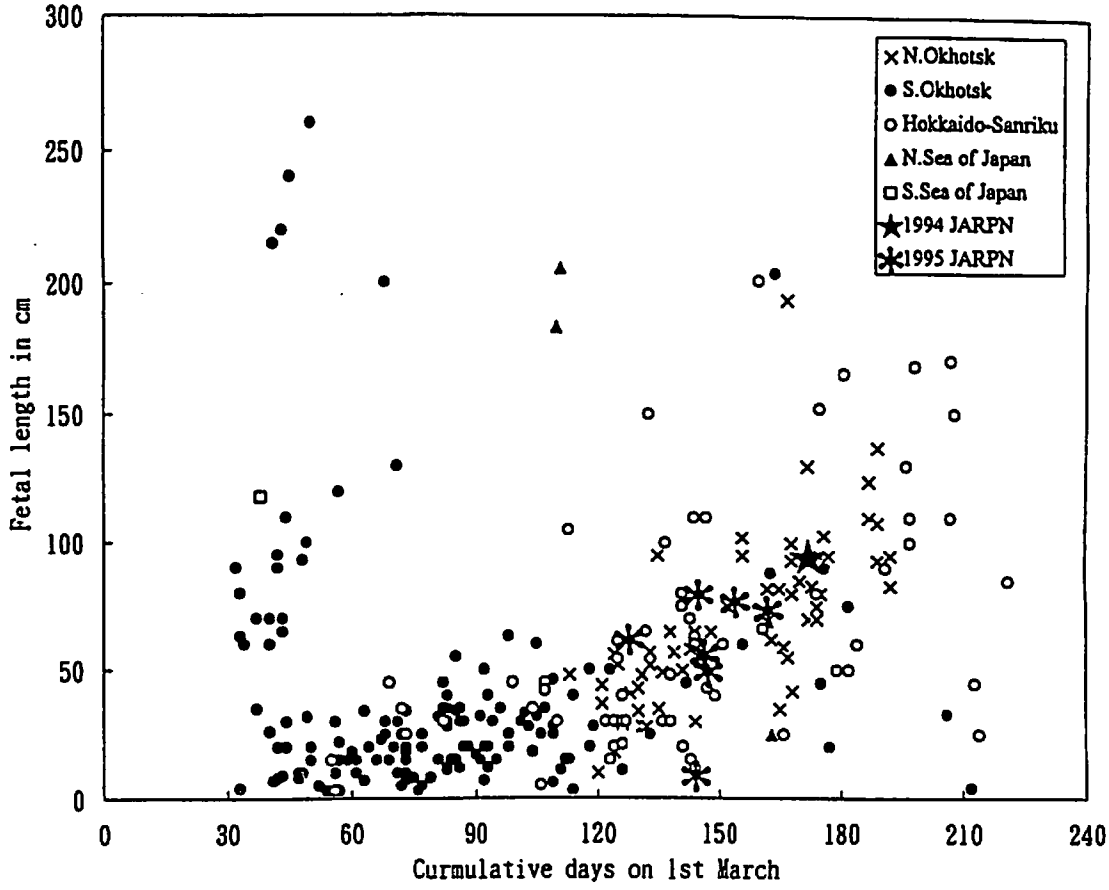


Fig. 6. Relationship between length of fetuses and collection date in minke whales from coastal water around Japan (Kato *et al.*, 1993) and from subarea 9 where conducted the JARPN surveys in 1994 and 1995.

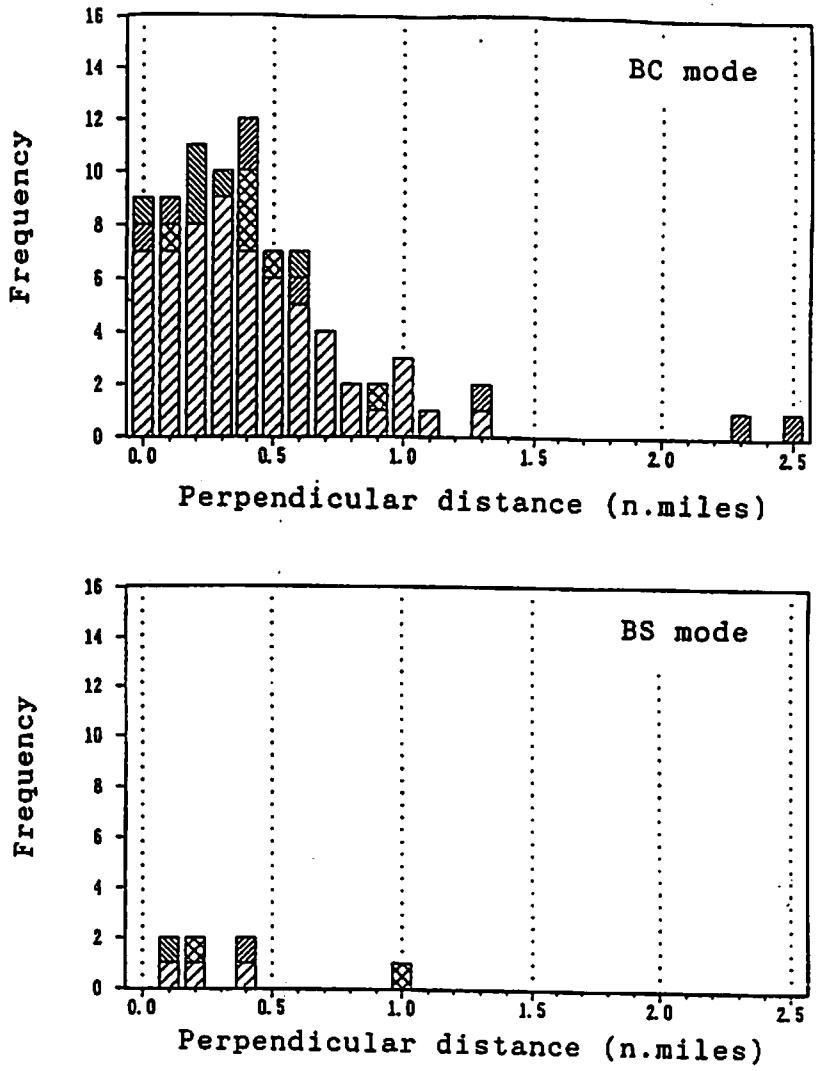


Fig. 7. Distribution of perpendicular distance for minke whale sighting under BC and BS mode surveys. Body: ▨, blows: ▩, jump: ▨, ring: ▧.

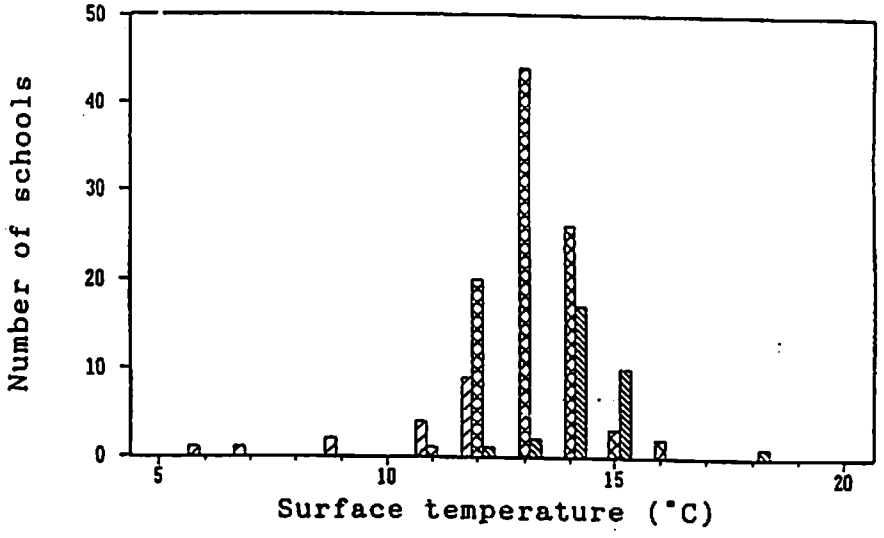


Fig. 8. Frequency distribution of sea surface temperature where minke whale sighted. First period: ▨, second period: ▩, third period: ▧.

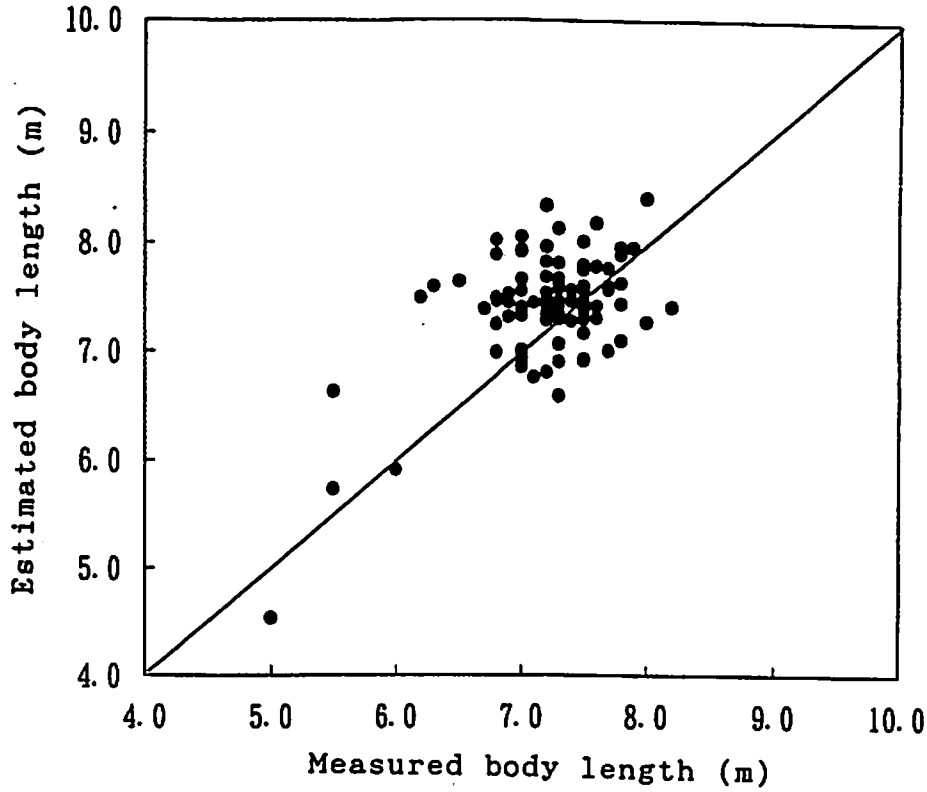


Fig. 9. Relationship between estimated body length (made by eye before sampling) and measured body length of minke whale in the 1995 JARPN survey.

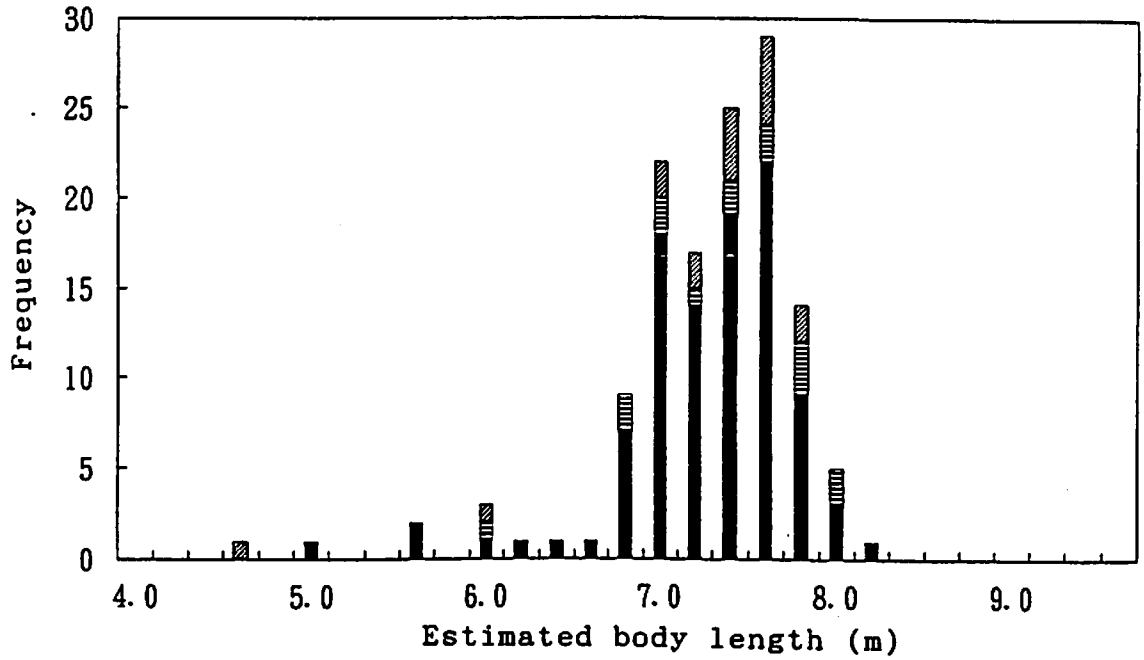


Fig. 10. Comparison of estimated body length composition among sampling event. ■ : Sampled whales, ▤ : Chasing and missing of the targeted whales, ▨ :Missing of the targeted whales before chasing.

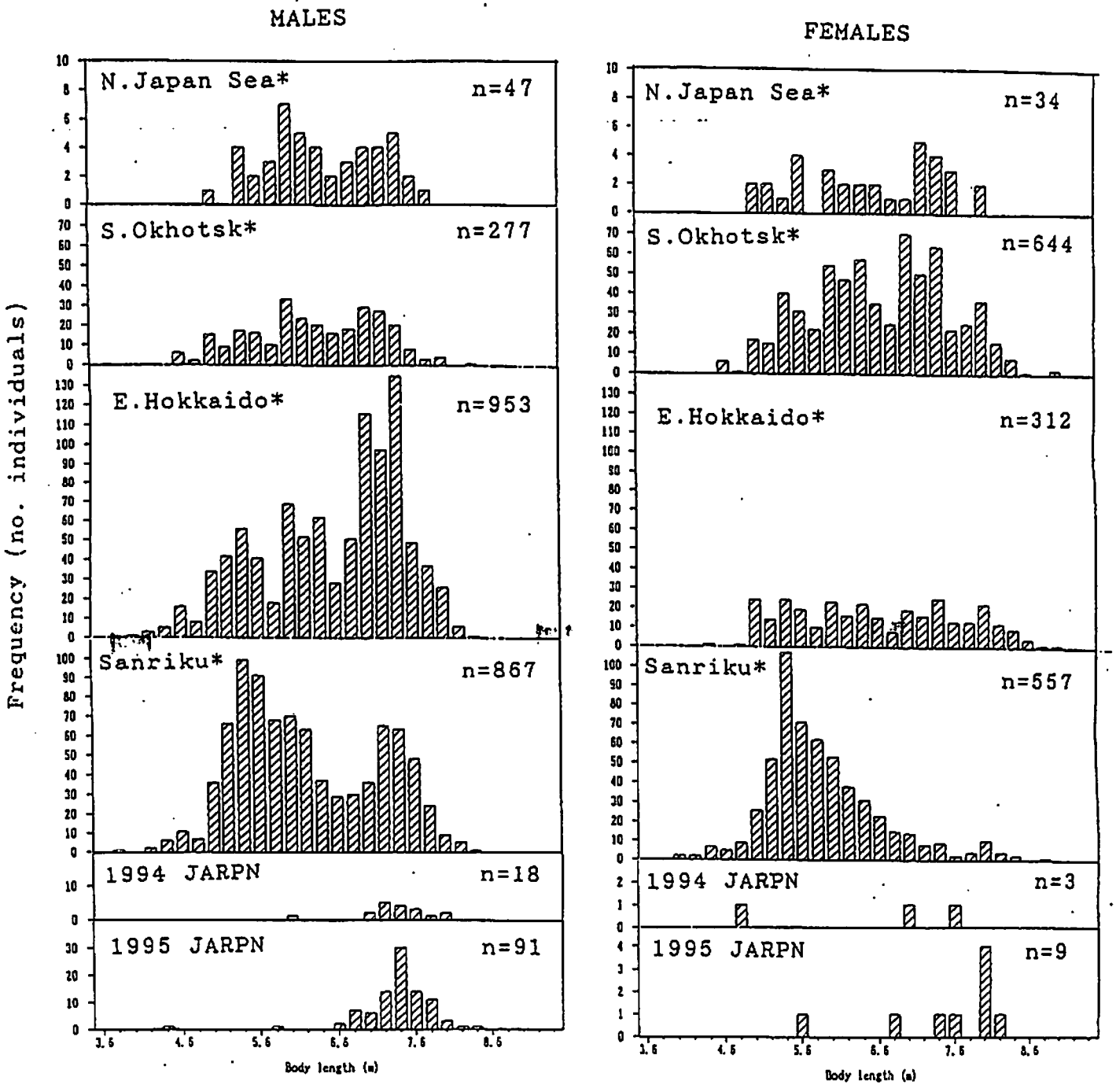


Fig. 11. Body length distribution of minke whales captured from 1977 to 1987, in four Japanese coastal whaling grounds. The length distribution of whales sampled in sub-area 9 by the JARPN survey in 1994 and 1995 are also shown. * After Kato (1992).